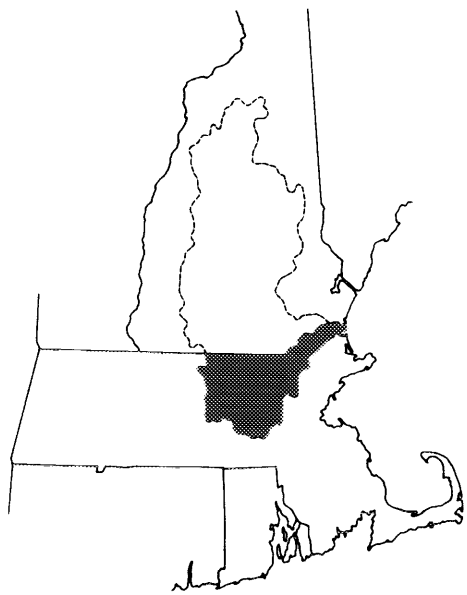
MERRIMACK WASTEWATER MANAGEMENT

key to a clean river

APPENDIX IV

IMPACT ANALYSIS AND EVALUATION



NORTHEASTERN UNITED STATES WATER SUPPLY STUDY NOVEMBER 1974

MERRIMACK WASTEWATER MANAGEMENT
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(KEY TO A CLEAN RIVER)

APPENDIX IV

IMPACT ANALYSIS AND EVALUATION

November 1974

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APPENDIX IV

IMPACT ANALYSIS AND EVALUATION

A. FOREWORD

Impact reports are oftentimes manifestations of unfulfilled expectations. It would be nothing short of euphoria if impact assessment findings could make important and complex decisions obvious for those that are in decision-making positions. The truth is impact assessments can only provide some meaningful insight as to what may be the consequences of a given choice of action. Impacts can also facilitate discussion and decisions by pointing out where additional information is needed to make the proper decision. Given that the human tendency is to expect too much from impact assessment, it is not difficult to understand the legacy of frustration inherent with attempting to utilize impact analysis and evaluation in the decision-making process. Remember it is merely a tool; also that impact analysis and evaluation will probably never be easy and attempts to make it such by relegating the process to some mystical cookbook formula is not unlike sticking one's head in the sand.

B. INTRODUCTION

The term "impact assessment" or "effects assessment" is synonymous and often substituted for the phrase of "impact analysis and evaluation." Whatever the terminology, the process by which impacts are generated is not amenable to a set pattern or a hard cast critical path. Those in the field of water resources planning and faced with the dilemmas of impact assessment should be continually looking over their shoulders throughout the planning effort anticipating some work will need to be redone. As experienced repeatedly throughout the Merrimack Study assumptions and facts will change and the forecasts of expected impacts associated with those facts and assumptions will therefore require modification. Oftentimes people's values change and those considerations deemed important in the beginning of a study might not carry the same weight when writing the final report.

If anything can be certain regarding impact assessment, it is that any worthwhile and credible analytical and evaluative process by necessity requires constant interaction with the public - whomever, wherever and at whatever level available resources permit to be reached. The general public, organized groups such as sportsmen's clubs and watershed associations, elected officials, planners and agency

representatives must all work together to resolve the complex problems that will certainly arise.

Planning means patience! It will not always be possible to satisfy all parties or to provide answers to all the critical questions. In some cases, answers will be available but oftentimes they will be educated guesses based on a combination of questionable assumptions and argumentative facts.

Each participant to the study should be cognizant of the fact that any chosen method of impact analysis and evaluation will be time consuming and frustrating. The public, the politicians, the planners and other professionals must all realize the process will not be perfect. Mistakes will be made. Inexperienced people will make many mistakes, experienced people should make a lesser number of mistakes.

Perhaps the most critical factor to remember is whatever the shape and dimensions of the process, it should be tailored and unique to the issues, needs, problems and desires of the people who must live with the decisions that are going to be made.

This appendix will document the impact assessment effort of the Merrimack River Wastewater Management Study Team. The team was comprised of representatives of Federal, State, regional and local agencies as well as members from professional consulting firms under contract to the New England Division of the Corps of Engineers. It will attempt to point out where mistakes were made and what could be changed or modified for purposes of facilitating and benefiting future studies. It will also highlight what techniques and methods may be worthy of future consideration.

A final word about the process itself. Just a few short years ago, impact assessment was a relatively new phrase with many and varied interpretations. The art or science of "how to do it" was embryonic. It still is! The point is that considerations other than costs and engineering criteria are beginning to bang on the door, the "unquantifiable" benefits and costs vs. the "quantifiable" facts, figures and dollars is the issue and therein lies the decision makers' nemesis. The methodology you will read about in the following pages may not be the best but it's an improvement on what was done five years ago and hopefully five years hence the process will be even better.

C. IMPACT ASSESSMENT AND PL 92-500

The overriding goal of the Merrimack River Wastewater Management Study was to formulate wastewater management alternatives that address the long range goals of the Federal Water Pollution Control Act Amendments of 1972 and to develop the implications and potential impacts of achieving those goals. These two goals are the achievement of "water quality which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water..." by 1983, and "that the discharge of pollutants into the navigable waters be eliminated" by 1985.

There has been much discussion, both favorable and adverse, about the feasibility and desirability of achieving the long range goal of "zero discharge of pollutants" by 1985. What are the associated costs and benefits? Not only monetary costs and benefits, but what are the biological, hygienic, aesthetic, economic and sociological costs and benefits as well? In other words, what do we gain or lose by implementing the advanced waste treatment systems and regional wastewater management strategies that the new law requires? Is it necessary or even desirable? What types of institutional or management structures are necessary to plan, design, build, operate, manage and maintain regional wastewater management systems? Can the communities and industries bear the additional expense or will new and creative financial arrangements be required? These are but a few of the multitude of questions addressed in this appendix.

People can talk about the unfeasibility of the new law all day and speculate on into the night. This study will attempt to answer some of the questions speculated upon and talked about throughout the Nation and it is within such a context that the impact assessments are presented. It should not be interpreted, however, that similar findings will be likely in other studies in other geographic areas with a different set of specific local and regional issues and problems.

D. THE NEED FOR IMPACT ASSESSMENT

Impact assessment facilitates discussion associated with the evaluation of alternative plans. Ideally it provides a mechanism for making rational choices and decisions. Impacts are forecasts of the future. They tell us what would be the probable changes both positive and adverse, to our social, political, economic, aesthetic, biological and hygienic environment if plan "X" were to be implemented. Impacts hopefully provide the answers or at least some insight into choosing a course of action that would be "best" based on all the available facts.

Impacts should also clarify choices between alternatives so that future options are not foreclosed. If we are going to grow and develop as a nation, as a community, and as a people, impacts can provide some basis for choosing amongst measures which will enable us to grow and develop in a manner which is conducive to our needs.

As noted earlier, impact assessment is a developing science. It's not by chance the process fails to provide all the answers to the questions asked. Some insight to the shortcomings of impact assessment can be gained from the fact that there is always a level of uncertainty in forecasting the future, circumstances far beyond our foresight have a dramatic effect on whether or not the stated impacts become realities. People change, values change, what is important today may not be important a few short years from now. Limited time and budget, and in a number of cases, limited data frequently dictate the level of certainty associated with the forecasts.

There is no "one best way" to do impact assessment. The process discussed in the following pages is the way it was done for the Merrimack Study; not that it's the right way, but rather the way thought best for the problems at hand. In all honesty, the process was never explicitly spelled out before the wheels started turning but rather the entire study effort was a learning experience for the members of the interagency study team. The impact assessment process actually evolved during the conduct of the study itself. This should not seem surprising since any methodology selected or developed should have the flexibility to change as new problems and needs arise - problems not anticipated during the initial phases of the study.

In any case, the impact assessment process should be structured and unique to a particular study or geographic area. What may work in the midwest where there is strong county government might not necessarily be effective here in New England where strong town government is the rule and vice versa.

The methodology must also be germane to the people of the study area. The people who live, work and pay taxes within the study area must be part and parcel to the entire process. They have to be given the opportunity for their voices to be heard. An understanding of the "how's" and "why's" is critical to those people that will be effected by implementation of a given plan. Concurrently, if the people of the study area are going to be requested to make decisions they must be given answers to the questions they ask. The dilemma of impact assessment, however, as pointed out earlier, is the answers are not always readily available.

The process of impact assessment used in the Merrimack Study recognized that the people living in the Merrimack River Basin wanted to know in very specific terms how the various alternatives would effect them. They wanted to know how the proposed plans would effect their daily lives in terms of recreational opportunities, local tax rates, municipal services, changes in town zoning ordinances, etc.

Impact assessment, however, must address all levels of decision-making - Federal, regional, State and local. Although the basic decisions concerning water resources management problems must be made at the state level and the town meeting level, more than local opinion has to be considered. This is particularly true of water quality management.

Water quality problems are regional problems and as such do not usually respect political or geographic boundaries. Fragmented geographic solutions or strategies to regional water quality problems have historically been less than successful. Improper zoning or inadequate land use controls on the tributaries of any river can only result in the degradation of the mainstem of the same river.

Regional solutions, therefore, have to be developed and their impacts assessed from the perspectives of a much higher level of government. The general well being of existing generations and generations to come can most effectively be assured by positive action from the Federal government. Impact assessment, therefore, has the obligation to be responsive to local issues but is equally bound to look beyond local needs to the much broader needs of the Nation as a whole.

The Water Resources Council Principles and Standards for Planning Water and Related Land Resources, adopted 25 October 1973, attempt to reflect the Federal interest in water quality planning projects. The Water Resources Council accounts and objectives of National Economic Development, Environmental Quality, Regional Development and Social Well Being are discussed beginning on page 91.

The need for impact assessment, however, can be much more basic and much more vital and not until recently has this new role been earnestly pursued. Traditionally, impact assessment was the justification of the decision. The DAD approach to planning - Decide, Announce, Defend - was common practice. Professionals in the water resources field have the proclivity to close the doors of their offices until they generate "the" solution or solutions. In a number of cases, the planning approach of, "We know what is best for the people!" has

led to any one or all of three evils: (1) extensive and costly litigation, (2) the filing of an expensive report on the shelf of the town library, or (3) additional studies.

Planning methods are changing, however, and change they must if they are going to be responsive to today's problems. The true value of impact assessment is not found in simply forecasting the impacts and the implications of engineering alternatives once the alternatives have been generated but rather having the impacts actually influence the design of the alternatives as they are being formulated. The Merrimack River Wastewater Management Study made an earnest attempt to have the various impact disciplines - biological, aesthetic, hygienic, institutional, financial and socio-economic - play an integral role in formulating structural and non-structural solutions to the wastewater problems of the Merrimack River Basin. (Structural solutions imply engineering facilities, buildings, etc., while non-structural solutions imply implementation of effective land-use management practices to prevent wastewater problems from occurring). The engineers did not develop the alternatives in a closet but rather functioned as part of a multi-disciplinary team to include sanitary engineers, aquatic biologists, agronomists, botanists, civil engineers, foresters, soil scientists, economists, sociologists, and geologists all working together to formulate a range of solutions to a common problem. The merits and drawbacks of such a multi-disciplinary team will be described later on in this appendix. Suffice it to say here that there is still need for much improvement in coordinating such a multi-disciplinary team. Improvement is needed in yet a more vital area as there are still many professionals within private consulting firms and governmental agencies charged with responsibilities in water quality management planning who have yet to seriously consider impact assessments as an integral part of the formulation of alternative solutions.

E. METHODOLOGY

1. Overview

Water resources planning is comprised of four basic activities:

(1) Definition of the problem and a statement of study objectives.

(2) Formulation of alternative solutions.

(3) Impact analysis of alternatives.

(4) Evaluation of alternatives.

Traditionally impact analysis and evaluation were seen as sequential steps in the overall planning process; each independent of the other, each to be taken in the above designated sequence. Today, however, significant and needed changes are being considered and made in planning methodologies. New and innovative techniques are being explored with computer technology often being utilized. In the Merrimack Wastewater Management Study, these changes manifest themselves into what can be considered as an iterative planning methodology. That is the basic planning activities were not taken as entities but rather they were taken together. Each carried out concurrently but with increasing degrees of refinement as the study proceeded; any one step providing the opportunity to make the others more meaningful and of greater resolution and quality. Feedback and reconsideration were the passwords.

If the iterative approach to planning seems to be anything but neat and tidy, that is because it is anything but neat and tidy. In most cases, it's down and out messy. Recognizing the desirability of an iterative planning process, this appendix then should not read explicitly of impact assessment. If it did, it could be seriously questioned. What is presented, however, is an amalagam of problem definition, plan formulation, impact analysis and impact evaluation.

This appendix will seek to lay out the entire process of impact analysis and evaluation for review. By nature of that process and due to extensive interagency cooperation, it was possible for the various Federal, State, regional and local agency representatives that participated in the planning effort as well as the various impact consultants under contract to the Corps of Engineers to develop a "recommended" plan. The recommended plan reflects general consensus and as such does not make claim to unanimous agreement between all study participants. This is particularly true with respect to recommendations for the Towns of Pepperell, Amesbury and Merrimac. The recommended plan is based on a full consideration of the various impact assessments, engineering considerations and the knowledge gained from the public participation program. It should be emphasized that the recommended plan is only a recommendation by the study team; an expression of what appears to be the best plan to implement to achieve the goals of PL 92-500. Secondly, the plan itself is not cast in concrete but rather is subject to change as new information becomes available.

The following pages will explain why and how the recommended plan was chosen and discuss the issues associated with that choice. This document will hopefully be a decision making tool. In some cases, the tradeoffs to be made will be difficult decisions. In a number of

instances the choices to be made will involve personal values and prejudices. Decisions will have to be made concerning alternative uses of our natural resources. Questions of land-use management as well as growth and development policies will be confronted. Policies will have to be set concerning issues that presently have no State or Federal policy. Which levels of government should exercise control over the operation and maintenance of treatment facilities in order to ensure the betterment of the region as a whole? Can land use controls be effectively implemented as a means of preventing non-point sources of pollution? Who enforces those controls?

Before continuing with an indepth discussion of the impact methodology, it should prove helpful to establish an understanding of the frequently used terminology. For purposes of this report, the following definitions of terms should be kept in mind:

. Impacts - The quantitative (dollars, user days of recreation, number of bushels of clams to be harvested, etc.) or qualitative (word description) statements of effects or changes that would potentially result from the implementation of any given wastewater management alternative.

. Impact Analysis - The process by which socio-economic, institutional-financial, aesthetic, hygienic and biological changes are identified and forecasted as a consequence of plan implementation.

. Impact Evaluation - Judging the changes delineated during impact analysis as positive or negative contributions to personal values, goals and objectives.

. Impact Discipline - Broad topics of impact analysis to include social and biological sciences. The impact disciplines used in this study were: socio-economic, hygienic, aesthetic, biological and institutional-financial. The institutional-financial considerations are presented separately in Appendix V.

. Impact Assessment - Term used to refer to a combination of the two separate processes of analysis and evaluation.

. Impact Category - Impact categories are indicators of change and are expressed for each discipline of impact analysis. Impact categories can also be referred to as analysis criteria. The following impact categories were utilized in this study:

1. Socio-Economic

   Population
   Agriculture
   Commercial Fisheries
   Manufacturing
   Service Sector
   Employment
   Personal Income and Wealth
   Housing
   Recreation
   Transportation
   Land Use
   Municipal Finance
   Municipal Services

2. Hygienic

   Water Supply
   Recreation
   Land Use

3. Aesthetic

   Visual Setting
   Culture
   Recreation

4. Biological

   Fish
   Invertebrates
   Aquatic Macrophytes
   Plankton
   Vegetation
   Groundwater
   Soils
   Wildlife

In addition to the above, the engineering criteria of costs, flexibility, resource requirements and reliability were utilized in the evaluation of the alternatives.

. Dominant Factors - Synonymous and often transposed for the term impact category.

. Community Profiles - Expressions of dominant factors used to describe existing conditions within the cities and towns of the study area.

. Baseline - The starting point of impact analysis which is used to measure and determine the magnitude of potential changes. The baseline can also be described as the set of conditions that would prevail in the study area if none of the alternatives presented in this study were to be implemented. For purposes of impact assessment in this report, the baseline was assumed to be the Environmental Protection Agency - State of Massachusetts Implementation Program which requires several communities within the study area to install secondary wastewater treatment facilities.

. Least Cost Plan - That wastewater management alternative which provides the minimum total expenditure of public funds. A point of clarification is needed, however, in that the "least cost" plan may apportion a higher total cost to an individual community than would be the case if that town "went it alone." This apparent contradiction is due to the fact the "least cost" plan is based on regional considerations rather than "every man for himself."

. Impact Plan - That wastewater management alternative which seeks to maximize beneficial and minimize detrimental socio-economic, aesthetic, biological and hygienic impacts. The "Impact Plan" deviates from and results in additional expenditures beyond the "least cost" plan where the results of impact analysis or the input from the public participation program justify such a change.

2. Impact Analysis

The impact assessment methodology utilized in the Merrimack Wastewater Management Study was a "going to school" exercise for all the members of the study team. A diverse group of specialists, biologists, engineers, economists, sociologists, political scientists, landscape architects, etc., were called upon to function in their respective fields of expertise as a coordinated team. It perhaps would prove useful to illuminate a few specific problems encountered before the team was even assembled.

The law of supply and demand, supply of available "in-house" staff and demand for their services, necessitated that "out of house"

assistance be obtained for impact analysis. As mentioned previously, a multi-disciplinary group possesses knowledge of many considerations that should be incorporated into the design of wastewater management alternatives as those alternatives are being formulated. In order to best provide that insight and guidance to plan formulation, it would be desirable if all the "players" could begin from the same starting point at approximately the same time; this is especially critical with short-fused planning studies.

Once the plan of study had been formulated and approved by the member agencies of the Merrimack Technical Subcommittee, contractual scopes of work were developed to acquire the assistance necessary to complete the designated work items. Each subcommittee member was given the opportunity to review and comment on the various scopes of work. During this plan of study - scope of work approval period, it took an inordinate amount of time for the study team to reach agreement on the "what to do" and "how to do it" issues. Perhaps this is to be expected when dealing with the varied interests reflected in the numerous Federal, State, regional and local agencies that directly participated in the study and the types of complex problems inherent with wastewater management planning. The time necessary to resolve the "whats" and the "hows" in combination with the various governmental policies regarding drafting and advertising scopes of work and negotiating contractual agreements dictated the lapse of approximately twelve months before all consultants had been acquired.

The connotations of "delay" can be well refuted. The argument would center on the fact the issues to be resolved needed to be resolved before the work could properly proceed. Although there is validity in such a rebuttal, the fact remains the actual planning tasks, particularly those associated with impact assessment, did not begin as soon as would have been desired in order to achieve maximum effectiveness. Time is the dearest of commodities in most planning studies and that which is not judiciously invested can only tarnish the quality of the final product. Methodologies and strategies for impact assessment have to be developed. Facts have to be generated or resurrected from the bookshelves. The necessary time-consuming tasks know no end.

Many of the time-consuming coordination and communication problems that came about as a result of acquiring "out-of-house" assistance may have been eliminated or alleviated if a complete "in-house" staff had been assembled; engineers, biologists, economists, etc. all working side by side in the same office. In retrospect, it

would have proven invaluable to have a complete "in-house" team communicating daily, developing methodologies together and discussing ideas and resolving common problems at coffee breaks, at lunch, or over a beer after hours. The human inclination to withdraw to the security of one's own office once tasks have been assigned must be compensated for in impact assessment methodologies. Infinite phone calling with numerous and sometimes unproductive coordination meetings are the current standard. The biological team member, sitting at the desk next to the economist who sits opposite the engineer may provide the more efficient mechanism that is needed.

If the contractual assistance route is the chosen path as it was in the Merrimack Study, there are certain problems which merit attention. Contracts for services in planning studies are difficult to write, oftentimes all encompassing, sometimes vague and always subject to interpretation, not by desire but due to the nature of the work that must be accomplished. As proven in the Merrimack Study, what was important while the various scope of services were being formulated might not necessarily be of prime consideration when the final reports are being written. Priorities change. Flexibility is the key. It is during the conduct and coordination of the study itself that a lot of the contract terminology is ironed out, phrases are clarified and the "how to do its" are resolved.

A consideration worth pursuing is to have the impact consultants develop a uniform methodology or common approach <u>together</u> through a quasi-study management group of key individuals from the respective consulting firms and the contracting agency. A foreseeable problem under such an approach is it presumes the consulting firms are under contract before the game plan is developed. There would be a natural hesitancy to undertake a contractual obligation without knowing exactly what would be required or what must be done.

Another point that may seem insignificant but is very crucial to the quality and credibility of the overall study and report is to make sure all study team members get out from behind the desk and travel through the study area! Background information reports prepared as recently as a year ago might not reflect what is happening in the study area today. An economic report documenting the depression in certain cities or towns only a few months before the study began might well be inaccurate if those towns currently have new programs for development or other "boot strap" operations. First hand knowledge of the study area also gives accuracy and credibility to the public participation program. The people can quickly sense whether a planner is familiar with the study area and its problems or is remote and insensitive to their needs and make up of their community.

Having established the necessity for additional assistance in impact assessment, certain basic decisions had to be made. In essence, there were two available options:

(1) Negotiate one large contract with a notable firm to do all of the impact analysis or;

(2) Award a number of smaller contracts with a variety of individual firms.

Dealing with only one firm would be easier from the logistics and coordination point of view and the necessary integration and interrelationships of impact disciplines would be less of a problem. On the other hand, there exists the temptation to abdicate responsibility under such an approach and say it is now the job of the consulting firm to tie all the impact disciplines together.

Biases and prejudices also have a greater opportunity to infuse the results and taint the objectivity of a report done by a single consultant. If a firm was selected that specialized in socio-economic analysis, then perhaps the biological, hygienic, or aesthetic disciplines would receive some lesser degree of effort.

Dealing with separate consultants - socio-economic, aesthetic, hygienic and biological - would propose more of a problem, however, in terms of coordinating the overall work effort. As an example, the economist could not discuss increased numbers of user days of recreation without the biologist first determining whether or not the nitrogen and phosphorus concentrations being discharged from sewage treatment plants would result in blooms of aquatic algae. It was also felt a better product could be obtained from an individual consulting firm with a given expertise.

The decision focused on one of integration vs. resolution - better individual reports at the potential cost of not being easily and neatly integrated. After weighing all considerations, the option of individual contracts for biological, aesthetic, socio-economic and hygienic impact assessment was selected. Pulling together all the impact reports into a coordinated logical format and discussion would therefore become the responsibility of the Corps in-house staff. One of the unforeseen pitfalls at the time of this decision was approximately six months would pass before all four impact consultants had been acquired. During this interim period, the Corps staff in conjunction with the Federal, State and regional agency representatives on the

Technical Subcommittee provided the needed guidance in formulating the engineering alternatives being prepared under a separate contract with a local engineering firm.

Once the complete study team had been formed, the difficulties associated with integrating the work efforts of each consultant began to arise. "Timeliness of data" best describes the problem. Before any one consultant could proceed with the development of a given impact category, he was oftentimes dependent on the output of another member of the team who in turn was dependent on someone else. Although there was always something that could be addressed while waiting for a needed piece of information, the principal implication was the original submittal dates for various work items had to be modified.

Monthly meetings with all impact consultants and the engineers were held at the Corps offices for exchanges of information and discussion of data needs and problems. More frequent meetings were held between two or three members of the study team as the need arose. It was immediately obvious at the first group meeting that terminology alone was going to be a problem. The term "impact analysis baseline" was defined in as many different ways as there were people in the room. In order to alleviate communication problems and minimize misunderstandings, terms were defined and "minutes of the meeting" were distributed to all participants.

It was also determined the geographical areas of analysis for each impact discipline needed to be different. Hydrological boundaries of river segments proved most conducive for analysis by the aquatic biologist while the socio-economic impacts were best investigated by SMSA's (Standard Metropolitan Statistical Areas), individual towns or groups of towns. The aesthetic and hygienic analyses required site specific investigations rather than a more generalized approach. Varying geographical area of analysis was not perceived to be a problem but a point to consider in the evaluation of alternatives since the "tradeoffs" were not always being compared on an equal basis.

Although each consultant had a somewhat different scope of analysis, the study team recognized the need for a common presentation format. The socio-economic impact assessment methodology was chosen to be the unifying structure for the following reasons:

(1) The methodology itself had been previously developed by the socio-economic consultant under a separate contract with the Environmental Protection Agency. In essence, the "How are we going to approach the problem," question had been answered.

(2) Many of the impact categories utilized in the socio-economic-methodology required the assistance and input of other members of the study team before they could be effectively developed. Impact categories such as commercial fisheries, recreation and agriculture required input from the biologists. The engineers needed to develop cost figures for each community before municipal finance impacts could be detailed. The discussion of land-use impacts required assistance from the Regional Planning Agencies.

(3) Many of the criteria utilized by the other consultants, criteria such as species diversity of benthic organisms and net present worth of facilities, etc., were not readily meaningful to the general public. These criteria although technically significant in themselves were best expressed through such terms as increased recreational opportunities and municipal tax rates.

(4) An additional consideration in selecting the socio-economic framework was the study's necessity to address the Water Resources Council's Principles and Standards. The biological, aesthetic, and hygienic disciplines, while addressing and incorporated into the Principles and Standards, do not lend themselves to be readily displayed in terms of the broad objectives and accounts of National Economic Development, Environmental Quality, Regional Development or Social Well Being. The various socio-economic impact categories developed with assistance from the other consultants were more amenable to the Principles and Standards.

(5) The final reason was the methodology could be easily used in the public participation program.

The methodology was developed for the Environmental Protection Agency and is called "A Handbook for Assessing the Social and Economic Impacts of Water Quality Management Plans," July 1973. The methodology is nicknamed "Boxes" and is best described as a checklist of impacts to be investigated during the planning effort. In essence, it is a matrix. The horizontal axis depicts various dominant factors that describe a community-land use, recreation, employment, municipal-finance, etc.; the vertical axis delineates a series of plan actions or those factors that describe a wastewater management alternative such as collection systems, construction activity, etc. Together, one plan action and one dominant factor, they formulate an impact. As an example, the potential impact on employment due to the construction of wastewater treatment facilities would be described and be used as a consideration in the decision-making process.

In order to invest the time and money available for impact assessment in the most judicious manner, priority impact categories were established. Given there were 10 plan actions and 13 impact categories, there were 130 potential impacts that could have been discussed in the socio-economic report alone. Assistance in establishing priorities was solicited from the public and the agencies of the Technical Subcommittee. Through the public participation program, an attempt was made to determine the issues and desires of the people in the study area. Community profiles, present day descriptions of each town in terms of manufacturing, employment, municipal services, recreational opportunity, etc. were developed to assist in documenting municipal needs. The guidance on what was important and what issues were of most concern came from a variety of sources - local officials, citizens groups, private citizens and agency representatives. Informal workshops, formal public meetings, interviews with local officials and citizen groups, phone calls and letters to the Corps of Engineers were the major techniques utilized in the pulse-taking effort. A variety of concerns surfaced which oftentimes were dependent on the geographical area under consideration or the specific problems of a given town. The recurring theme, however, seemed to focus on the following major issues:

(1) How would the technical alternatives be financed? What would it cost each town?

(2) Who would operate and maintain the regional treatment systems called for in the technical alternatives? Would small towns be forced to tie into big city systems and be gobbled up by big city politics?

(3) How would implementation of regional solutions affect existing land-use patterns? Would community growth and development policies have to be altered?

(4) What increased benefits could be realized from spending additional money and going beyond the existing program for secondary treatment? Is advanced treatment necessary?

(5) Should the problems of non-point sources, combined sewers and stormwater overflows be corrected before requiring additional treatment of municipal wastes?

Logically, the impact categories of municipal finance, water quality and related recreation and land use were given the major consideration in the impact analysis. Less significant impacts were not

overlooked or discarded but rather were given a lesser degree of consideration. The institutional/political issue warranted detailed discussion in a separate appendix (Appendix V) which is part of this report. Since any discussion of recreational benefits is dependent on water quality considerations, close coordination was needed among the engineering, biological and socio-economic consultants. The anticipated water quality improvements from implementing any of the alternatives are addressed in the biological report (Appendix IV-B).

As mentioned previously, the Merrimack Wastewater Management Study was a prototype in regional wastewater management planning with the principal task of addressing the goals and requirements of the Federal Water Pollution Control Act Amendments of 1972, particularly the requirements of Sections 201 and 208. One of the problems confronting the study team was the varying interpretations of the requirements of the Act, particularly with respect to Sections 201, 208 and 303. During the initial phase of the study, Environmental Protection Agency guidelines regarding specific sections of the Act were not available. As a consequence, the contractual scopes of work written for impact assessment were very ambitious. The language in the Plan of Study was also ambitious. What the study team thought they could do and what could be accomplished with the money and time available were in some cases very different. The discrepancy between what was hoped to have been accomplished and what was actually accomplished led to some problems during the later stages of the study as the Technical Subcommittee began to evaluate the alternatives and attempt to generate a recommended plan. Some agency representatives felt more information was needed on costs and the various impact assessments before a recommended plan could be agreed upon. Others felt the available information was sufficient. Compromise was in order. The study team agreed to proceed with recommendations recognizing that the availability of new information could well change those recommendations.

3. Impact Evaluation

Frequently looked upon as the planner's nemesis, impact evaluation is thought of being mystical in character and configuration and difficult to accomplish. It's perceived to be difficult because it implies making trade-offs among potential benefits and costs and confronting a wide range of personal value judgments in the decision-making. How do you decide and who decides what is best becomes the question.

Impact evaluation is usually presented as one of the final chapters of a lengthy report and relegated to a few simple matrices or charts that are not always significant to the people who make significant decisions. Charts and matrices summarizing a wide range of diverse impacts do serve a useful purpose but they are not ends in themselves. Evaluation should be a process of communication and discussion. The meetings and the dialogue that manifests itself in the form of charts and matrices - public meetings, public workshops, Technical Subcommittee workshops, phone calls, letters, and meetings with elected officials, selectmen, mayors, and town managers - are the real impact evaluation and not the pluses (+) and minuses (-) commonly associated with concise statements of findings. The meeting halls are the arena for the expression of value judgments and the consideration of potential trade-offs. The planner's role is to facilitate the dialogue by describing and displaying the various impacts associated with the alternatives so that the issues can be focused and decisions can be made.

Evaluation is an attempt to reach agreement among a wide range of interests. Due to this premise, the following pages will read differently than customarily expected in a discussion of impact evaluation; especially if the reader is familiar with the many diverse methods of evaluation. It will read differently because it will attempt to document how the Merrimack Wastewater Management Study Team reached agreement on what should be done to solve the existing and future wastewater management problems of the communities in the Merrimack River Basin. That consensus of opinion is manifested in the "recommended plan."

In the following discussion, it is important to recognize there are two kinds of evaluation, one inherent with planning water resources projects, the other explicit, both being vital and inextricably interdependent.

1. Inherent evaluations are technical considerations and involve selection of those factors utilized in the development and screening of a wide range of alternatives such as the design criteria for advanced waste treatment plants or land application systems.

2. Explicit evaluations involve analyzing the associated impacts of a specific number of alternatives and making trade-offs among those impacts in an effort to develop or select the "best" plan.

Recognizing the interrelationship of the two kinds of evaluation, the following discussion will focus on the explicit impact evaluation

process utilized to develop the recommended plan. The "recommended plan" should be looked upon as a recommendation - an expression of what appears to be the best plan to implement to achieve the goals and requirements of the Federal Water Pollution Control Act Amendments of 1972. Whether or not the goals of the Act are changed at some future date is not an issue in this report. It is entirely possible, however, that the results of this study will affect some legislative modification to the new law.

The effort to achieve consensus was a difficult endeavor. The Technical Subcommittee's sincere attempt to reach some level of agreement is unique in itself and marks an encouraging new trend in interagency cooperation. Many planning studies simply present a range of alternatives and leave the selection of the best alternative to some nebulous process. The means and methods to implement the plan, if a plan can in fact be chosen, is even more of a mystique which seldom excludes interagency conflict. The highest hurdle is that of implementation - selecting a plan and getting it off the paper and onto the land. It is hoped the designation of the recommended plan will serve as the needed catalyst for implementation or at a minimum serve as the focal point for ensuing discussion and investigations.

The development of the recommended plan by the Technical Subcommittee is based on a full consideration of the various impact reports, best professional engineering judgment and perhaps most importantly on the knowledge acquired through the public participation program. Specific plans individually optimizing such factors as economic development, environmental quality, or social well-being and the various preference sets that could hypothetically be used as a basis for plan selection were not developed. Preference sets and plans that individually optimize environmental quality benefits or maximize socio-economic benefits can be of value but often lead to the high hurdle mentioned previously.....now that we've got the plans how do we decide which is best and by what process? A more important consideration as experienced in the Merrimack Study is that, many times, what local people need and want is an amalgam of environmental quality and socio-economic benefits - not black or white, but gray.

One of the major findings of the Merrimack Study was perceived benefits due to regionalization of wastewater treatment facilities were not borne out in the impact analysis. The individual conclusions of the biological, socio-economic, aesthetic, hygienic, engineering and institutional reports were that decentralized systems would offer the most beneficial or least adverse impacts. In addition, significant differences between alternatives were only delineated when

the issue concerned the mode of treatment (land treatment vs. water-oriented facilities) and the degree of regionalization (several towns tied into one facility or a few towns). As an example, the impacts did not readily differentiate between alternatives 3 and 4 (water centralized vs. water regional) but significant differences did surface between alternatives 1 and 4 (water decentralized vs. water regional) or alternatives 1 through 4 compared to alternative 5 (water treatment vs. land treatment).

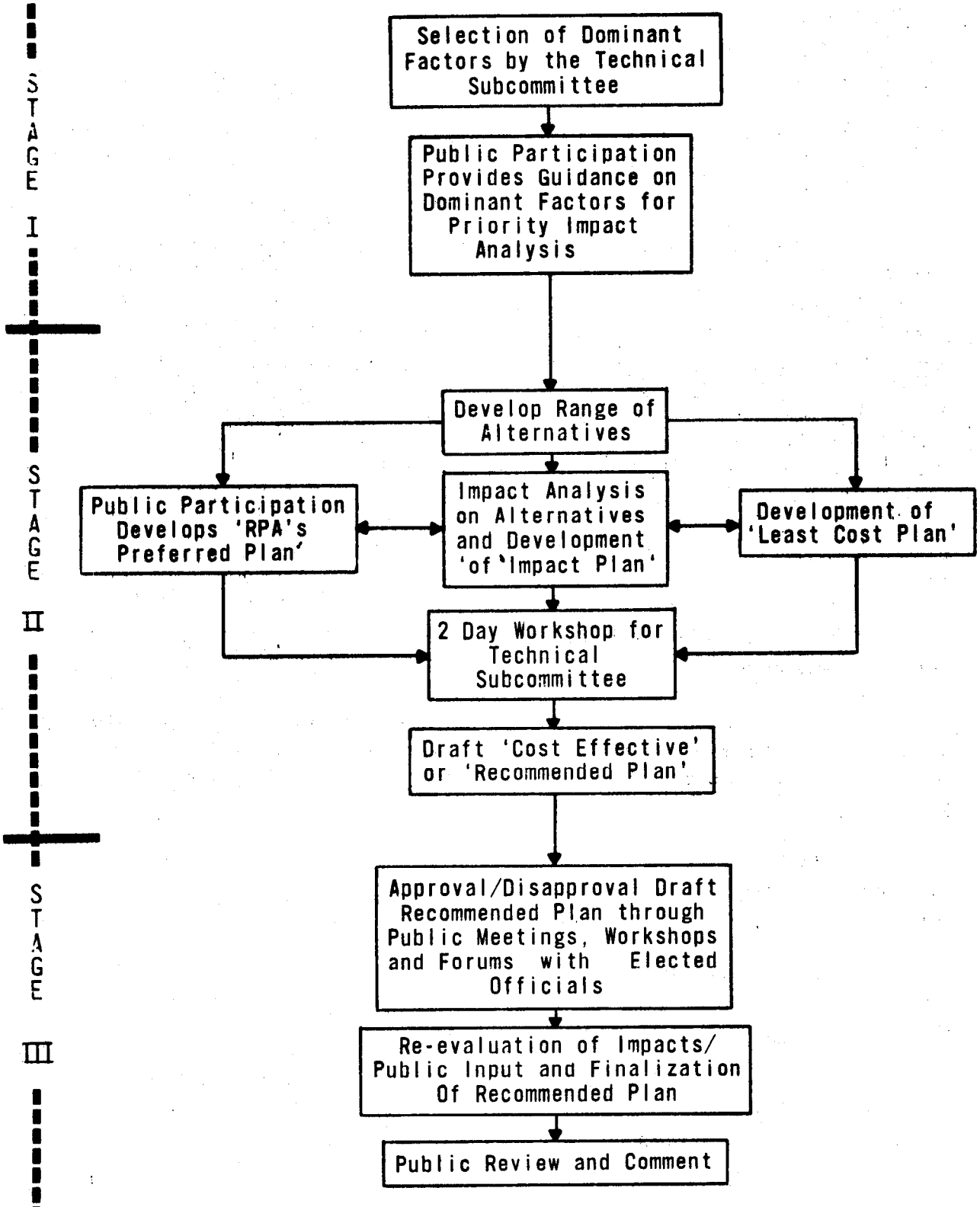
A major difficulty in developing the recommended plan through comparing and evaluating the alternatives and their associated impacts was the dollar costs of the alternatives did not markedly differentiate when compared on a net present worth basis. Since the existing State-EPA program for secondary treatment was accepted as the foundation of this study, the site of existing or proposed treatment facilities had in most cases been determined and the cost of transmission systems needed to accommodate large regional facilities more than offset the monetary benefits of regionalization.

Another problem in the evaluation was many of the issues on which value decisions and judgments had to be made were inextricably tied to other issues not directly affected by wastewater management. As an example, the Subcommittee found itself evaluating the impacts of nonstructural (land management) strategies for rural communities and confronting the issues of land use based on wastewater management while other considerations such as economic growth policies, housing policies and open space or recreation issues might be the overriding factors on which ultimate decisions concerning land use should be made.

The recommended plan is not a plan unto itself but rather is a composite of other alternatives. It was generated through a series of meetings with study consultants, members of the Technical Subcommittee and the Citizens Advisory Group and local elected officials.

The various impact reports were reviewed and discussed at length with forums and workshops being held for elected officials of the towns within the study area. As can be seen from Figure 1, the recommended plan is in reality the culmination of a series of planning steps undertaken during the study. A range of engineering alternatives addressing various modes of treatment (land or water) and varying degrees of regionalization (centralized and decentralized) were detailed for each of the regional planning agencies within the study area (Figures 3-7 and 9-14). Facilities proposed under the on-going State-EPA implementation program (Figures 2 and 8) were incorporated into the

EVALUATION FLOW CHART



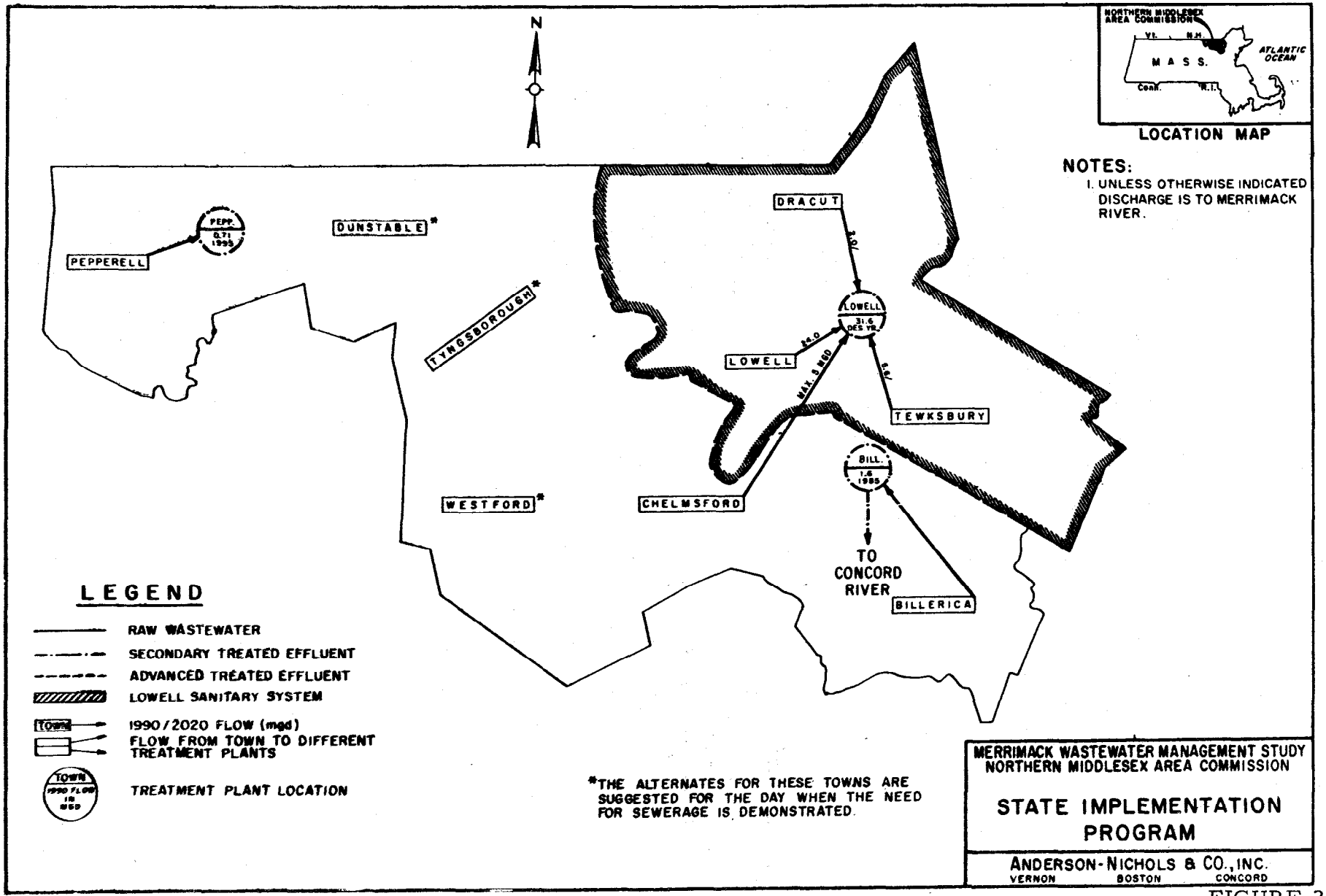

N
NORTHERN MIDDLESEX AREA COMMISSION
Vt.
N.H.
MASS.
Conn.
R.I.
ATLANTIC OCEAN
LOCATION MAP
NOTES:
1. UNLESS OTHERWISE INDICATED DISCHARGE IS TO MERRIMACK RIVER.
PEPP.
0.71
1995
PEPPERELL
DUNSTABLE*
TYNGSBOROUGH*
DRACUT
5.0
LOWELL
31.6
DES YR.
LOWELL
24.0
MAY. 2 MGD
5.0
TEWKSBURY
BILL.
1.6
1995
WESTFORD*
CHELMSFORD
TO CONCORD RIVER
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
STATE IMPLEMENTATION PROGRAM
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 2

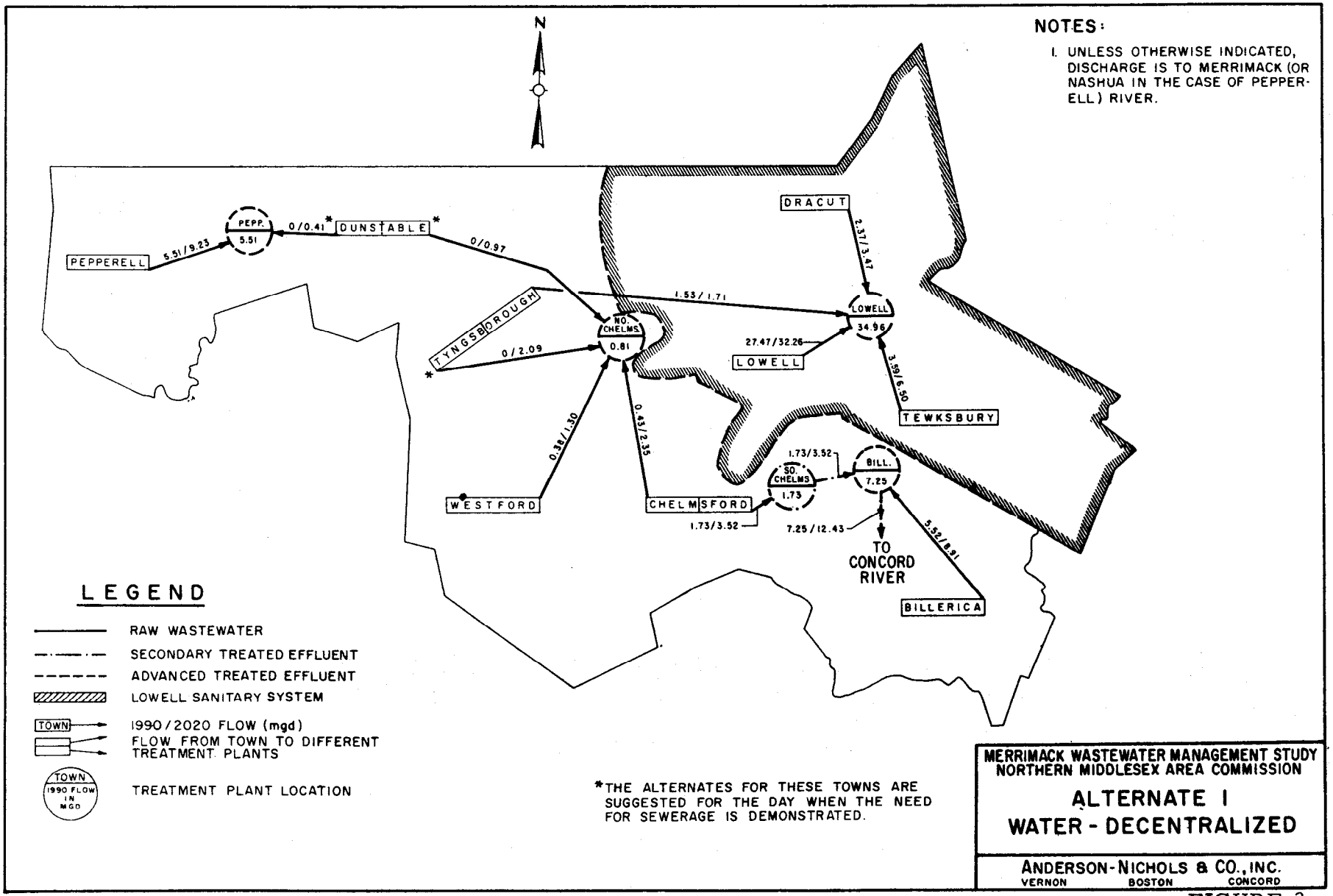

N
NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER.
PEPPERELL
5.51/9.23
PEPP.
5.51
0/0.41
DUNSTABLE
0/0.97
TYNGSBOROUGH
0/2.09
NO. CHELMS.
0.81
1.53/1.71
DRACUT
2.37/3.47
LOWELL
34.96
27.47/32.26
LOWELL
3.59/6.50
TEWKSBURY
0.38/1.30
WESTFORD
0.43/2.35
CHELMSFORD
1.73/3.52
SO. CHELMS.
1.73
1.73/3.52
BILL.
7.25
7.25/12.43
TO CONCORD RIVER
5.52/8.31
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
ALTERNATE I
WATER - DECENTRALIZED
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 3

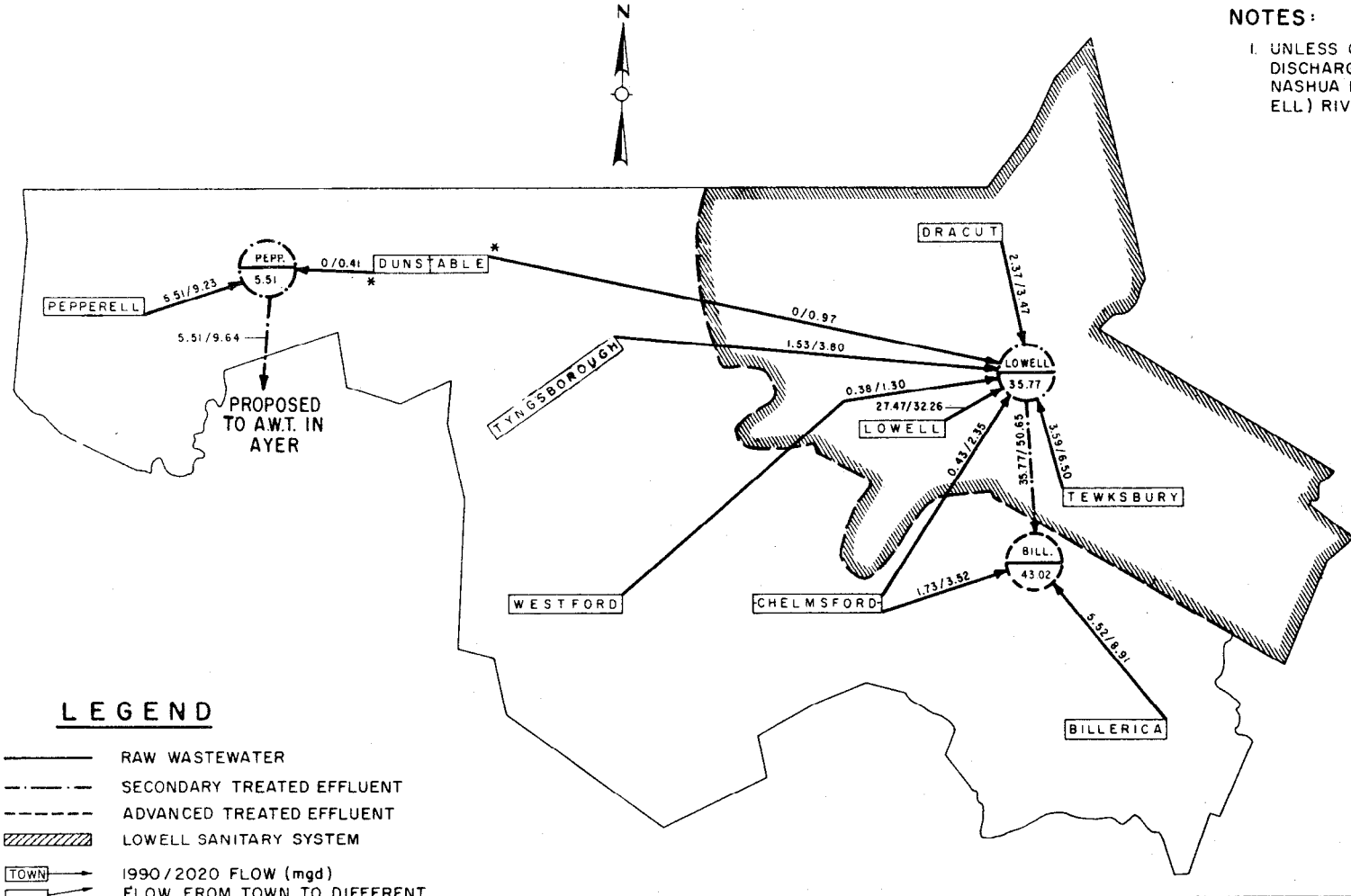

N
NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER.
PEPPERELL
5.51/9.23
PEPP.
5.51
0/0.41
DUNSTABLE
5.51/9.64
PROPOSED TO A.W.T. IN AYER
0/0.97
1.53/3.80
TYNGSBOROUGH
DRACUT
2.37/3.47
LOWELL
35.77
0.38/1.30
27.47/32.26
LOWELL
0.43/2.35
35.77/50.65
3.59/6.50
TEWKSBURY
BILL.
43.02
WESTFORD
CHELMSFORD
1.73/3.52
5.52/8.91
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
ALTERNATE 2
WATER - PARTIALLY DECENTRALIZED
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 4

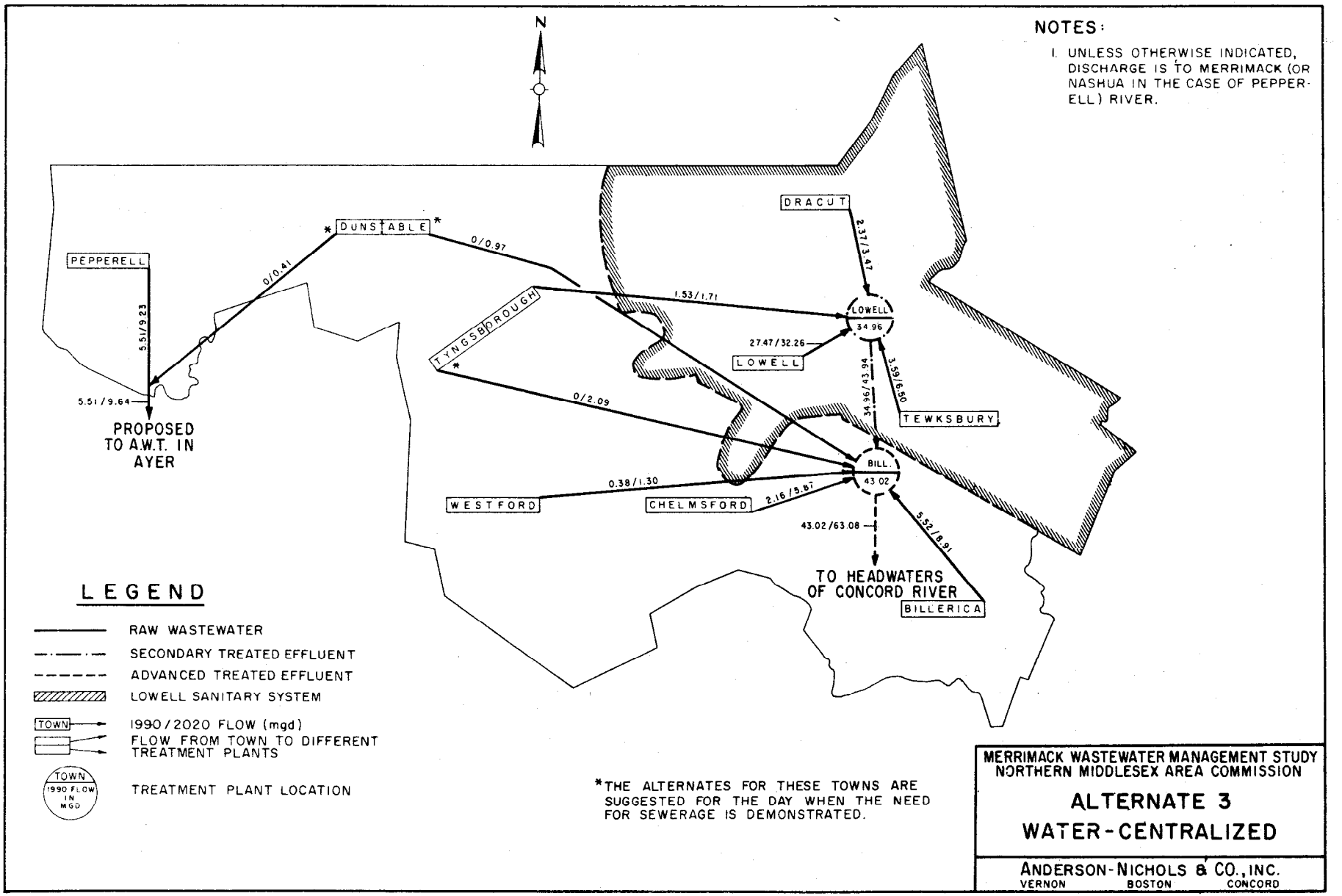

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER.
N
PEPPERELL
DUNSTABLE
0/0.41
0/0.97
5.51/9.23
5.51/9.64
PROPOSED TO A.W.T. IN AYER
TYNGSBOROUGH
0/2.09
DRACUT
2.37/3.47
1.53/1.71
LOWELL
34.96
27.47/32.26
LOWELL
34.96/43.94
3.59/6.50
TEWKSBURY
BILL.
43.02
0.38/1.30
WESTFORD
CHELMSFORD
2.16/5.87
43.02/63.08
5.52/8.91
TO HEADWATERS OF CONCORD RIVER
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
ALTERNATE 3
WATER-CENTRALIZED
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 5

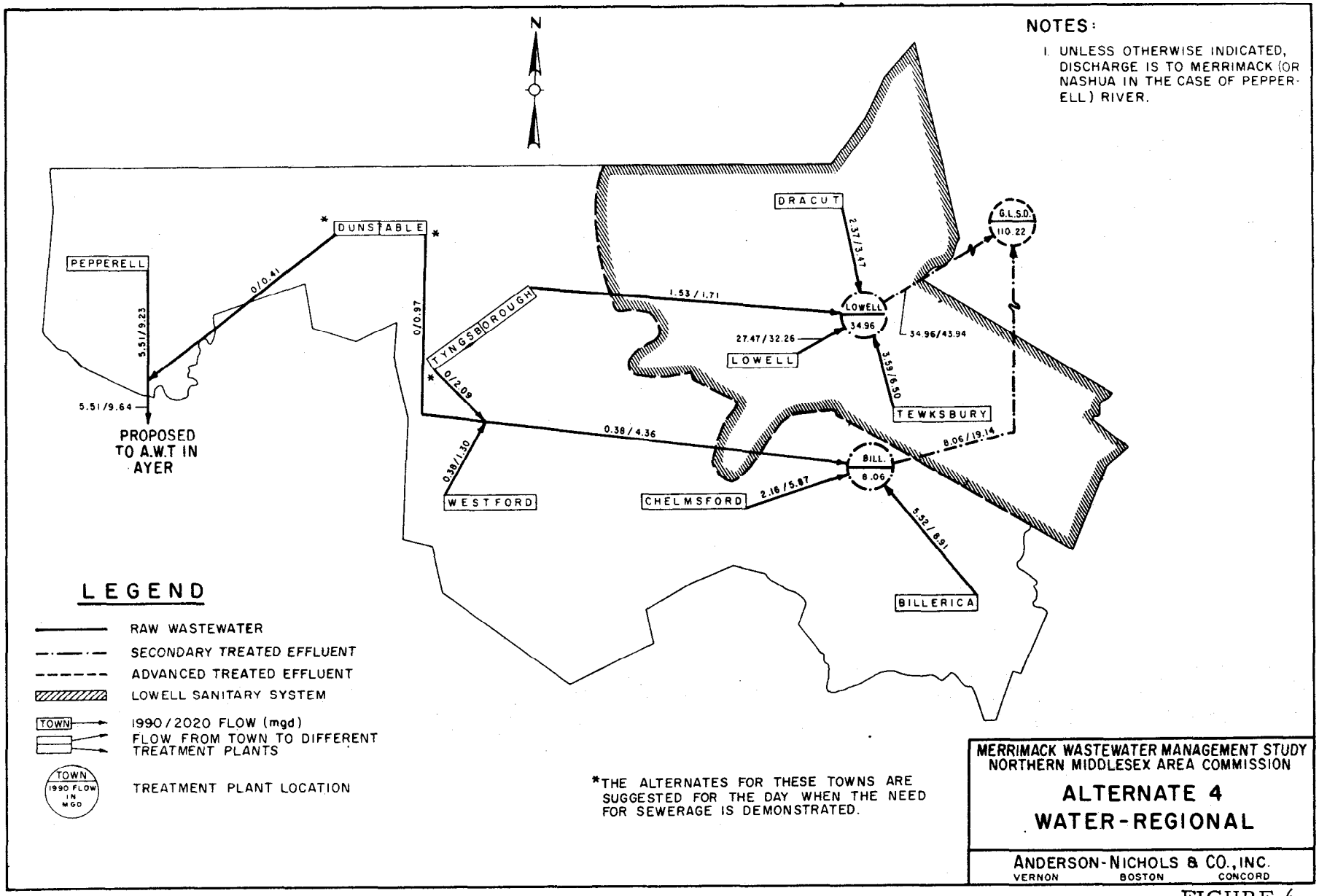

N
NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER.
DUNSTABLE
PEPPERELL
0/0.41
5.51/9.23
5.51/9.64
PROPOSED TO A.W.T IN AYER
0/0.97
TYNGSBOROUGH
0/2.09
0.38/4.36
0.38/1.30
WESTFORD
DRACUT
2.37/3.47
G.L.S.D.
110.22
1.53/1.71
LOWELL
34.96
27.47/32.26
LOWELL
34.96/43.94
3.59/6.50
TEWKSBURY
8.06/19.14
BILL.
8.06
2.16/5.87
CHELMSFORD
5.52/8.91
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
ALTERNATE 4
WATER-REGIONAL
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 6

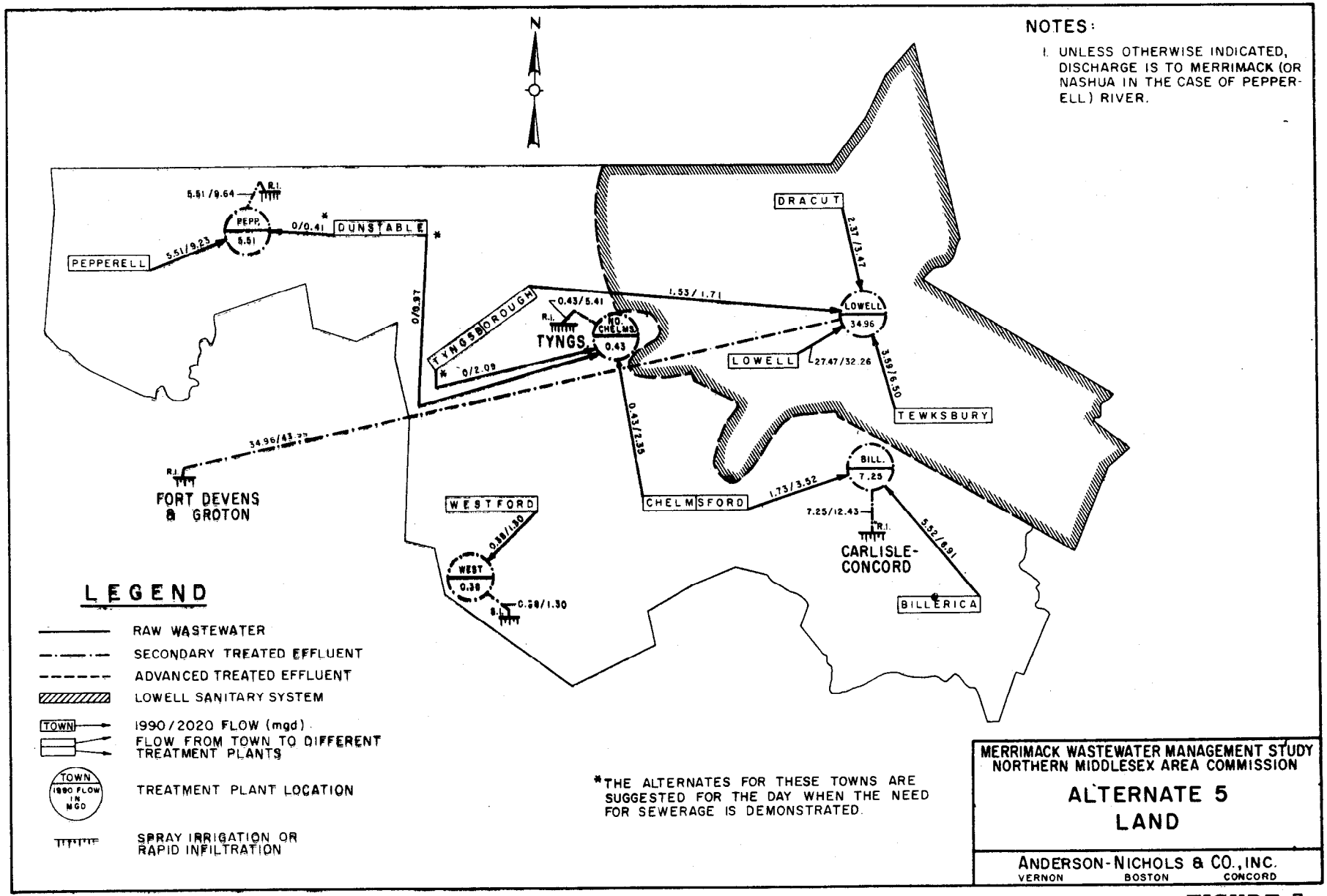

N
NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER.
PEPPERELL
DUNSTABLE
TYNGSBOROUGH
TYNGS
NO. CHELMS.
LOWELL
DRACUT
TEWKSBURY
CHELMSFORD
WESTFORD
BILL.
CARLISLE-CONCORD
BILLERICA
FORT DEVENS & GROTON
R.I.
5.51/9.64
5.51/9.23
0/0.41
0/0.97
0/2.09
0.43/5.41
1.53/1.71
2.37/3.47
27.47/32.26
3.59/6.50
0.43/2.35
1.73/3.52
7.25/12.43
5.52/8.91
0.38/1.30
0.38/1.30
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN 1990/2020 FLOW (mgd).
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN 1990 FLOW IN MGD
TREATMENT PLANT LOCATION
SPRAY IRRIGATION OR RAPID INFILTRATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
ALTERNATE 5
LAND
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 7

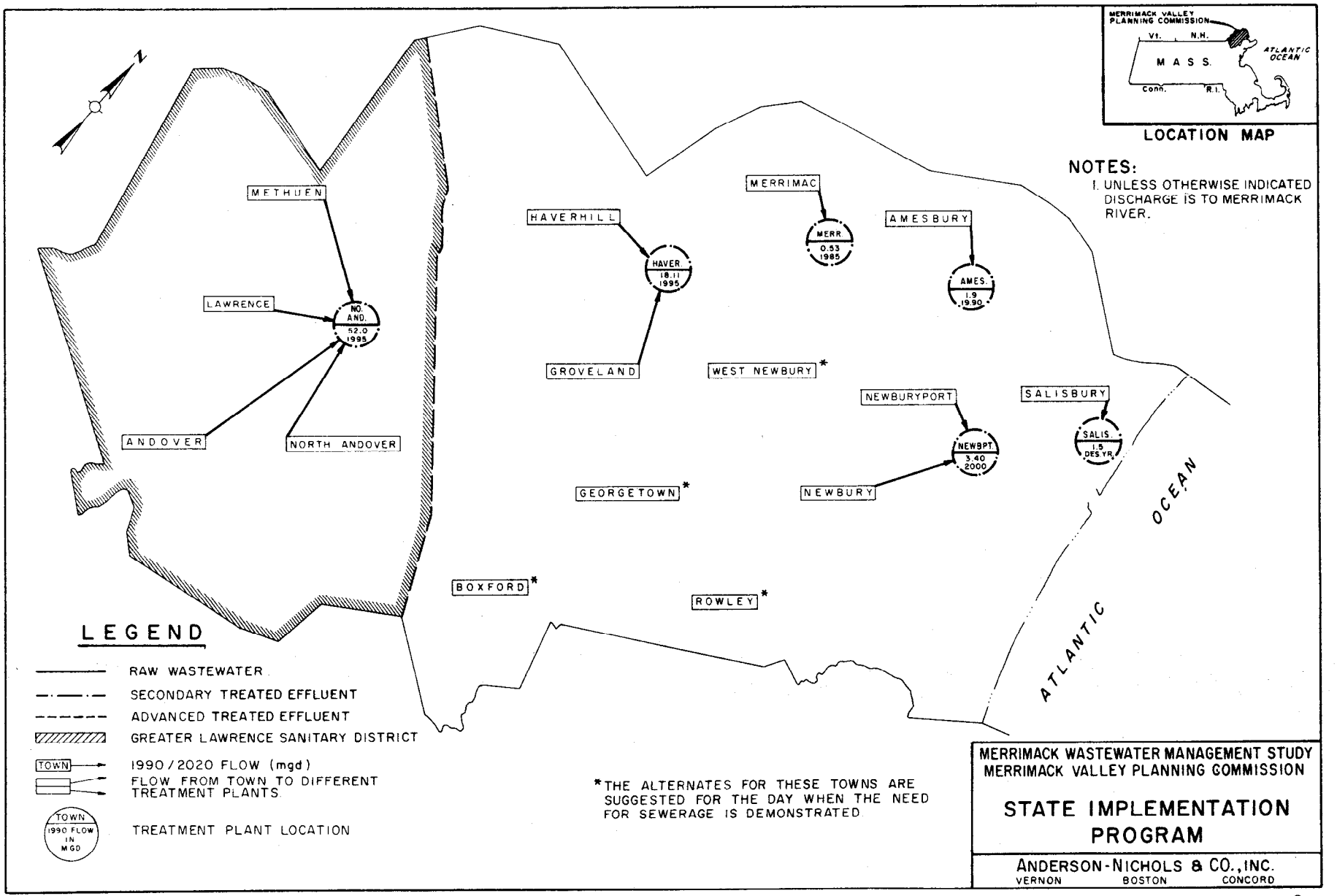

MERRIMACK VALLEY PLANNING COMMISSION
Vt.
N.H.
MASS.
Conn.
R.I.
ATLANTIC OCEAN
LOCATION MAP
NOTES:
1. UNLESS OTHERWISE INDICATED DISCHARGE IS TO MERRIMACK RIVER.
METHUEN
LAWRENCE
NO. AND. 52.0 1995
ANDOVER
NORTH ANDOVER
HAVERHILL
HAVER. 18.11 1995
GROVELAND
MERRIMAC
MERR. 0.53 1985
AMESBURY
AMES. 1.9 1990
WEST NEWBURY *
NEWBURYPORT
NEWBPT 3.40 2000
NEWBURY
SALISBURY
SALIS. 1.5 DES YR.
GEORGETOWN *
BOXFORD *
ROWLEY *
ATLANTIC OCEAN
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN 1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
STATE IMPLEMENTATION PROGRAM
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 8

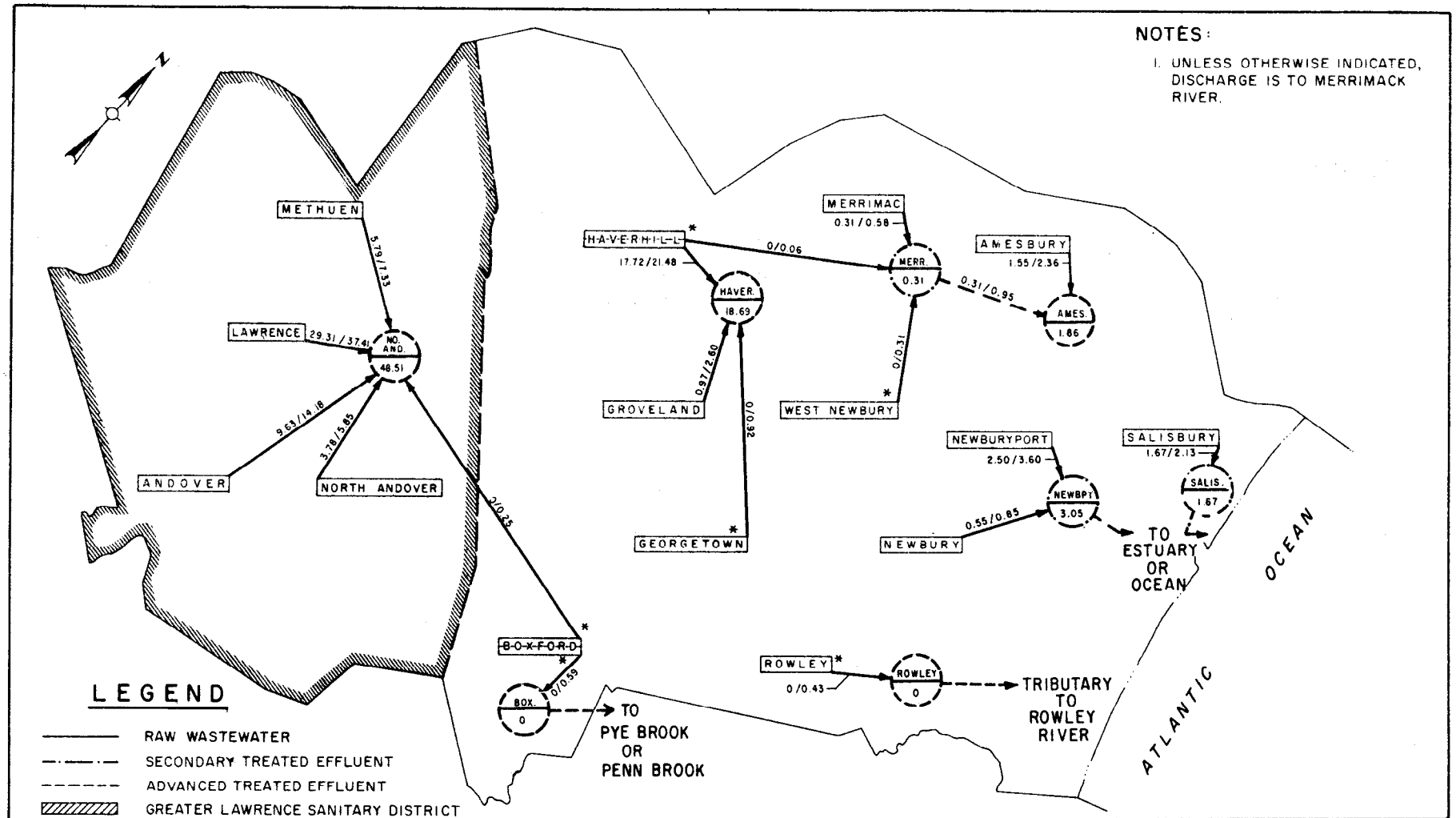

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
METHUEN
5.79/7.33
LAWRENCE 29.31/37.41
NO. AND. 48.51
9.63/14.18
3.78/5.85
ANDOVER
NORTH ANDOVER
0/0.25
BOXFORD
0/0.59
BOX. 0
TO PYE BROOK OR PENN BROOK
HAVERHILL
17.72/21.48
0/0.06
MERRIMAC
0.31/0.58
MERR. 0.31
AMESBURY
1.55/2.36
0.31/0.95
AMES. 1.86
HAVER. 18.69
0.97/2.60
GROVELAND
0/0.32
GEORGETOWN
WEST NEWBURY
0/0.31
NEWBURYPORT
2.50/3.60
NEWBPT 3.05
0.55/0.85
NEWBURY
SALISBURY
1.67/2.13
SALIS. 1.67
TO ESTUARY OR OCEAN
OCEAN
ROWLEY
0/0.43
ROWLEY 0
TRIBUTARY TO ROWLEY RIVER
ATLANTIC
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN 1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS.
TOWN 1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
ALTERNATE 1
WATER - DECENTRALIZED
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 9

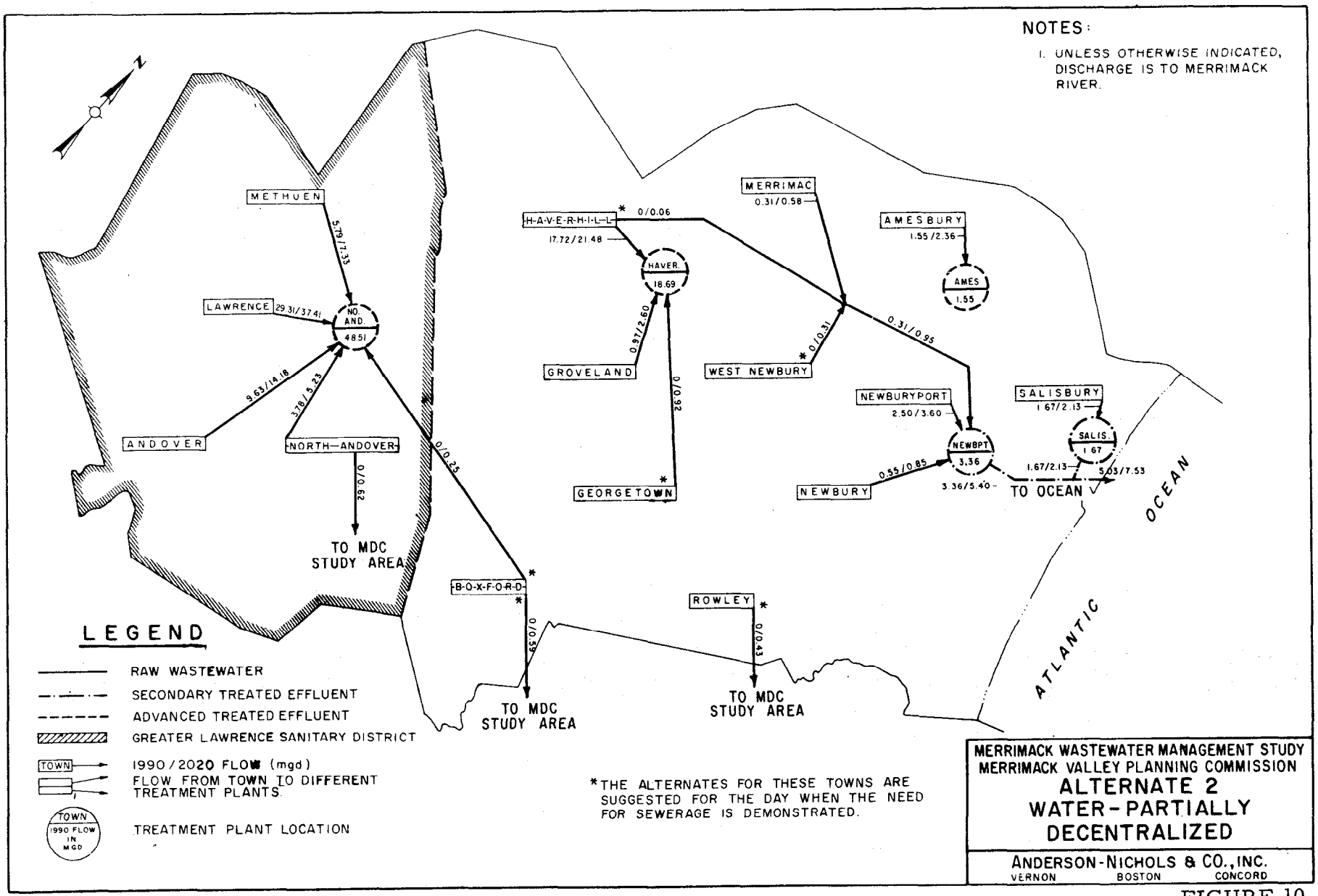

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
METHUEN
5.79/7.33
LAWRENCE 29.31/37.41
NO. AND. 48.51
9.63/14.18
3.78/5.23
ANDOVER
NORTH-ANDOVER
29.0/0
TO MDC STUDY AREA
0/0.25
HAVERHILL
0/0.06
17.72/21.48
HAVER. 18.69
0.97/2.60
GROVELAND
0/0.92
GEORGETOWN
MERRIMAC
0.31/0.58
0/0.31
WEST NEWBURY
0.31/0.95
AMESBURY
1.55/2.36
AMES 1.55
NEWBURYPORT
2.50/3.60
NEWBPT 3.36
0.55/0.85
NEWBURY
3.36/5.40
SALISBURY
1.67/2.13
SALIS. 1.67
1.67/2.13
5.03/7.53
TO OCEAN
OCEAN
ATLANTIC
BOXFORD
68.0/0
TO MDC STUDY AREA
ROWLEY
0/0.43
TO MDC STUDY AREA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN 1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
ALTERNATE 2
WATER-PARTIALLY DECENTRALIZED
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 10

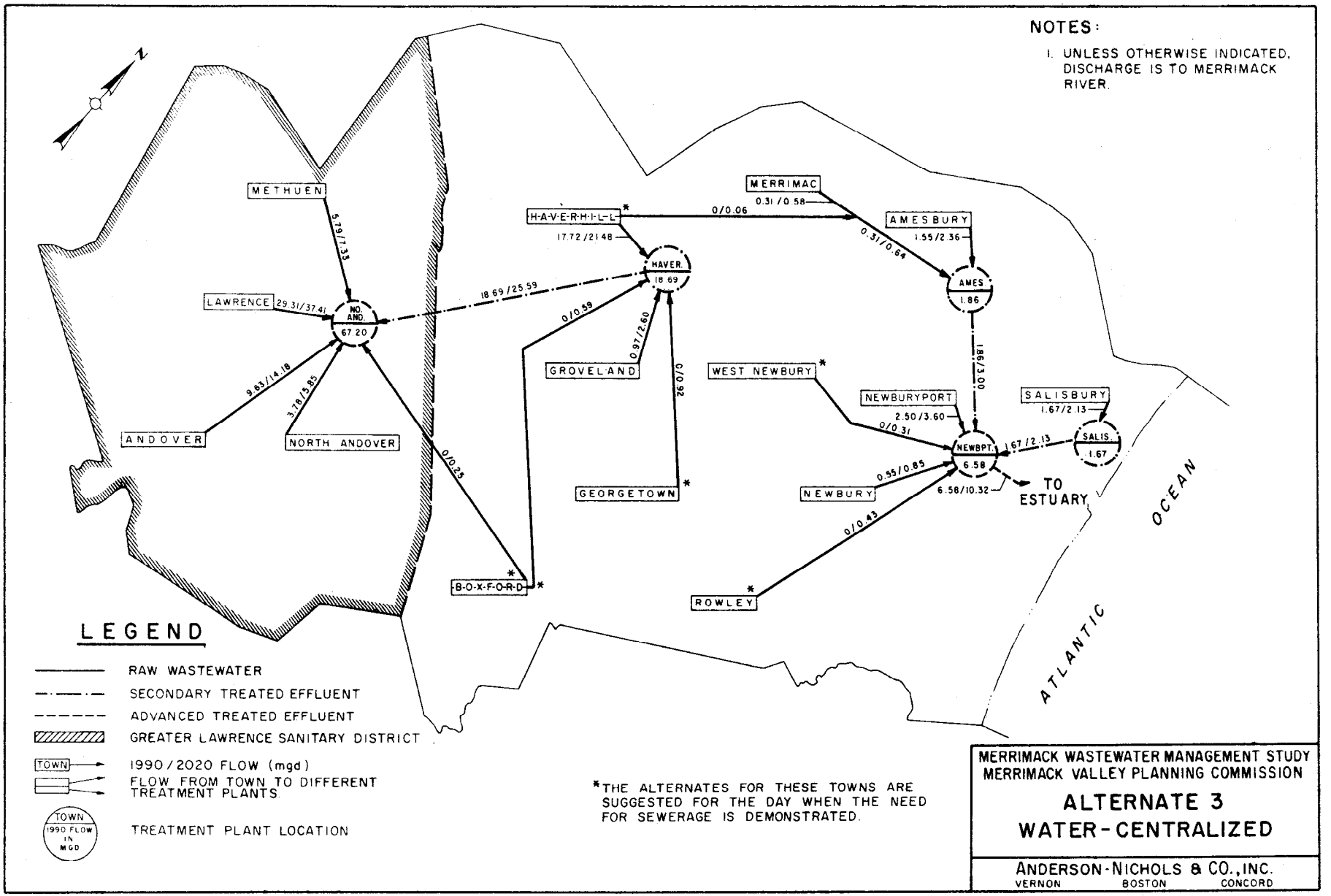

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
N
METHUEN
5.79/7.33
LAWRENCE 29.31/37.41
NO. AND. 67.20
18.69/25.59
HAVER. 18.69
H-A-V-E-R-H-I-L-L *
17.72/21.48
0/0.06
MERRIMAC
0.31/0.58
AMESBURY
1.55/2.36
0.31/0.64
AMES
1.86
1.86/3.00
0/0.59
0.97/2.60
GROVELAND
0/0.92
GEORGETOWN *
WEST NEWBURY *
NEWBURYPORT
2.50/3.60
0/0.31
SALISBURY
1.67/2.13
NEWBPT. 6.58
1.67/2.13
SALIS. 1.67
0.55/0.85
NEWBURY
6.58/10.32
TO ESTUARY
0/0.43
ROWLEY *
9.63/14.18
3.78/5.85
ANDOVER
NORTH ANDOVER
0/0.25
B-O-X-F-O-R-D *
ATLANTIC OCEAN
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN 1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN 1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
ALTERNATE 3
WATER-CENTRALIZED
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 11

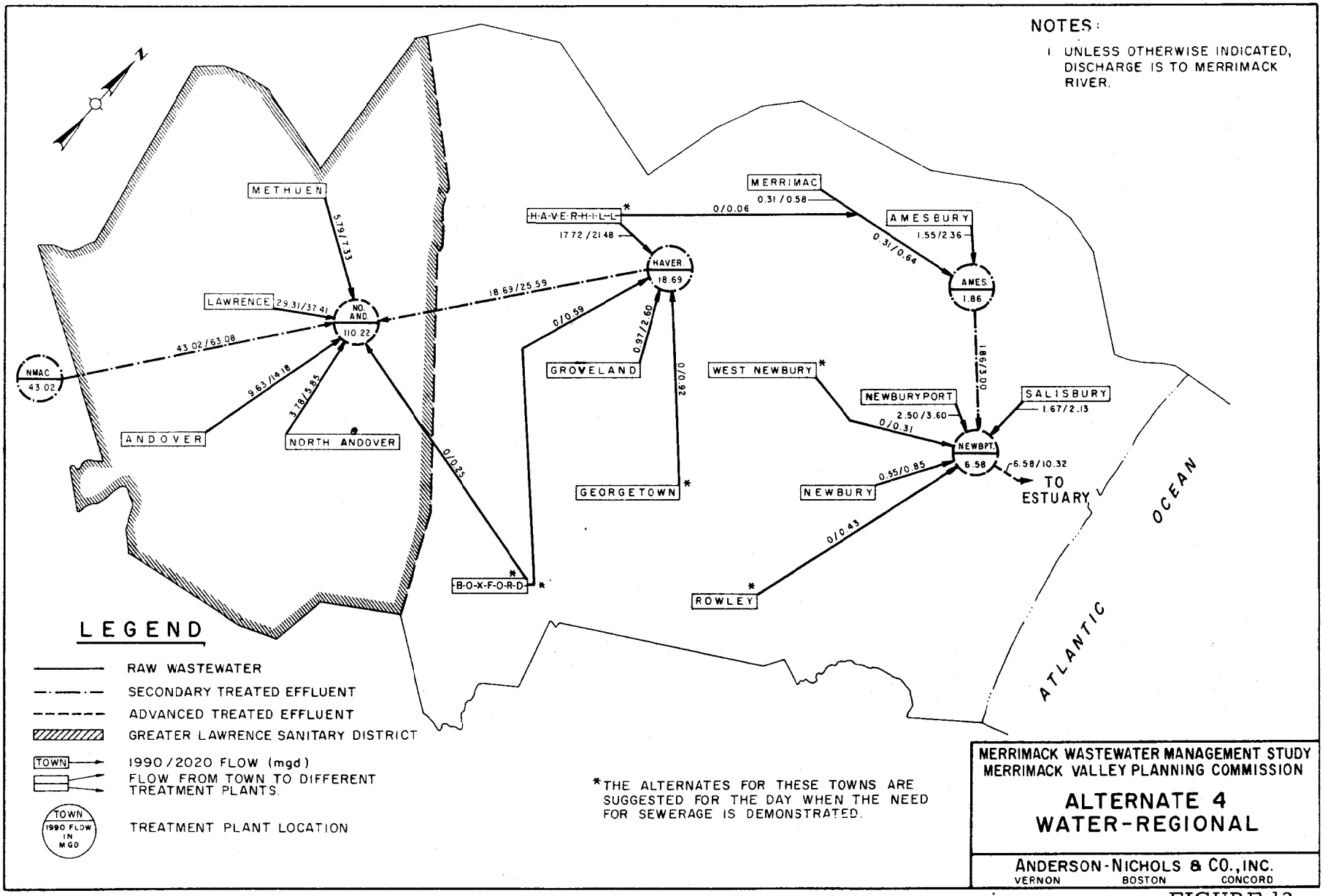

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
N
METHUEN
5.19/7.33
LAWRENCE 29.31/37.41
NO. AND 110.22
43.02/63.08
NMAC 43.02
9.63/14.18
3.78/5.85
ANDOVER
NORTH ANDOVER
18.63/25.59
HAVERHILL*
17.72/21.48
HAVER. 18.69
0/0.59
0.97/2.60
0/0.92
GROVELAND
GEORGETOWN*
0/0.25
BOXFORD*
MERRIMAC
0.31/0.58
0/0.06
AMESBURY
1.55/2.36
0.31/0.64
AMES. 1.86
1.86/9.00
WEST NEWBURY*
NEWBURYPORT
2.50/3.60
0/0.31
SALISBURY
1.67/2.13
NEWBPT. 6.58
6.58/10.32
TO ESTUARY
0.55/0.85
NEWBURY
0/0.43
ROWLEY*
ATLANTIC OCEAN
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN 1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS.
TOWN 1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
ALTERNATE 4
WATER-REGIONAL
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 12

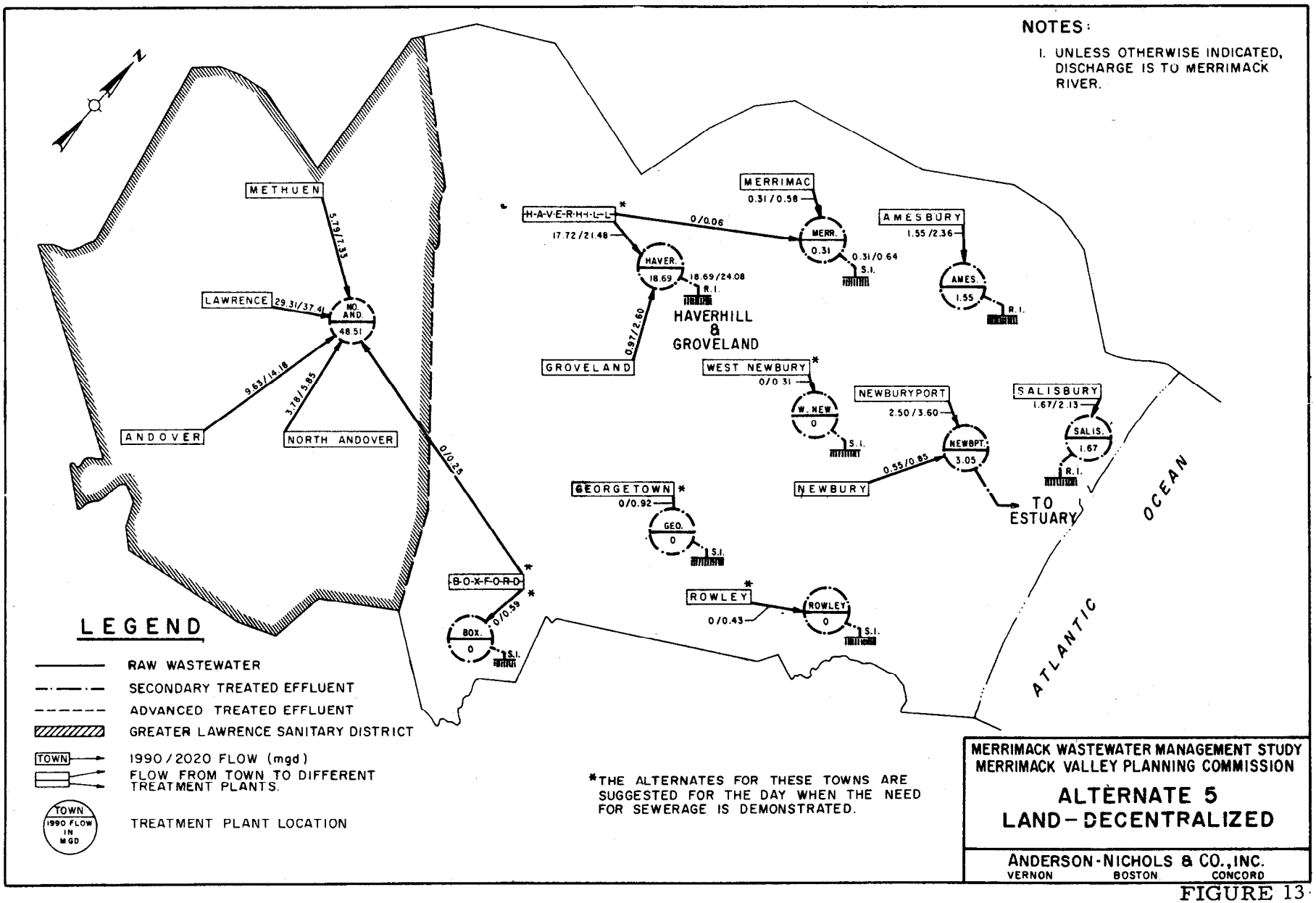

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
METHUEN
5.79/7.33
LAWRENCE
29.31/37.41
NO. AND.
48.51
9.53/14.18
3.78/5.85
ANDOVER
NORTH ANDOVER
0/0.25
HAVERHILL*
17.72/21.48
0/0.06
HAVER.
18.69
18.69/24.08
R.I.
0.97/2.60
GROVELAND
HAVERHILL & GROVELAND
MERRIMAC
0.31/0.58
MERR.
0.31
0.31/0.64
S.I.
AMESBURY
1.55/2.36
AMES.
1.55
R.I.
WEST NEWBURY*
0/0.31
W. NEW
0
S.I.
NEWBURYPORT
2.50/3.60
NEWBPT.
3.05
0.55/0.85
NEWBURY
SALISBURY
1.67/2.13
SALIS.
1.67
R.I.
TO ESTUARY
OCEAN
ATLANTIC
GEORGETOWN*
0/0.92
GEO.
0
S.I.
BOXFORD*
0/0.59
BOX.
0
S.I.
ROWLEY*
0/0.43
ROWLEY
0
S.I.
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS.
TOWN 1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
ALTERNATE 5
LAND-DECENTRALIZED
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 13

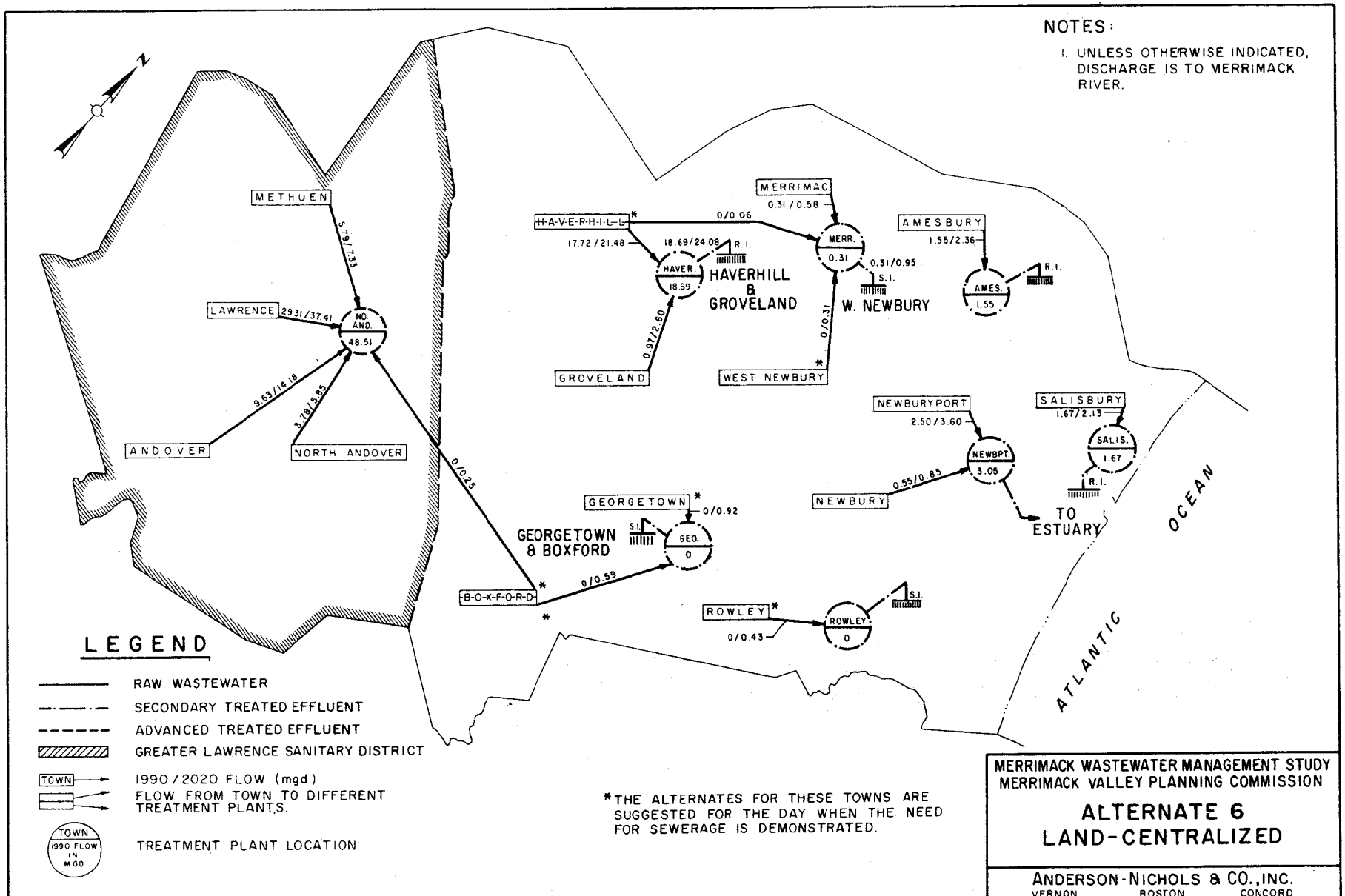

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
N
METHUEN
5.79/7.33
LAWRENCE
29.31/37.41
NO. AND.
48.51
9.63/14.18
3.78/5.85
ANDOVER
NORTH ANDOVER
0/0.25
MERRIMAC
0.31/0.58
H-A-V-E-R-H-I-L-L
0/0.06
17.72/21.48
18.69/24.08
R.I.
HAVER
18.69
HAVERHILL & GROVELAND
MERR.
0.31
0.31/0.95
S.I.
W. NEWBURY
AMESBURY
1.55/2.36
AMES.
1.55
R.I.
0.97/2.60
GROVELAND
0/0.31
WEST NEWBURY
NEWBURYPORT
2.50/3.60
NEWBPT.
3.05
0.55/0.85
NEWBURY
SALISBURY
1.67/2.13
SALIS.
1.67
R.I.
TO ESTUARY
OCEAN
ATLANTIC
GEORGETOWN
0/0.92
S.I.
GEO.
0
GEORGETOWN & BOXFORD
B-O-X-F-O-R-D
0/0.59
ROWLEY
0/0.43
ROWLEY
0
S.I.
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS.
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
ALTERNATE 6
LAND-CENTRALIZED
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 14

design of all alternatives for advanced waste treatment. The impact consultants were requested to delineate the impacts for all alternatives. (Appendix IV-A, IV-B, IV-C, IV-D). Once the construction and operation and maintenance costs had been developed for each alternative, a hybrid "least cost" alternative was formulated by the engineering consultants. The least cost alternatives (Figures 15 and 16) were developed from the component parts of the original eleven alternatives.

The public participation program played a vital role in the evaluation and development of the recommended plan. The regional planning agencies presented the eleven alternatives (five for the Northern Middlesex Area Commission and six for the Merrimack Valley Planning Commission) and the preliminary findings of the impact assessments to their constituents through a series of meetings and workshops with commission members, elected officials and local citizenry. The main objective of this series of meetings was to gain some local preference or feeling for an alternative the public would support. Public feedback expressed concern and skepticism over large regional treatment figurations. Some communities equated their experiences in attempting to establish regional school systems with regionalization for wastewater management saying they had "learned the hard way about the so-called benefits of regionalization." This interim public evaluation of the alternatives served an additional purpose since the public had the opportunity to check the planners to be sure the issues surfaced during the initial phase of the study were in fact being considered in the development of the alternatives.

In the Merrimack Valley Planning Commission area, the alternative preferred by the public consisted of component parts of alternatives 1, 2, 3, and 6 plus additional configurations not found in any of the alternatives. What they were in essence saying was they did not like any one alternative in particular but did like pieces of number one, part of number six, some of their own design, etc. The preferred plan for the Northern Middlesex Area Commission closely resembled alternative number one. These public participation hybrids became known as the Regional Planning Agencies Draft Preferred Plans (Figures 17 and 18).

The consultants' impact reports became the basis of developing yet another alternative known as the "impact plan." These plans were formulated from component parts of the original eleven alternatives and were based on maximizing socio-economic, biological, aesthetic and hygienic benefits without considerations as to monetary costs (Figures 19 and 20).

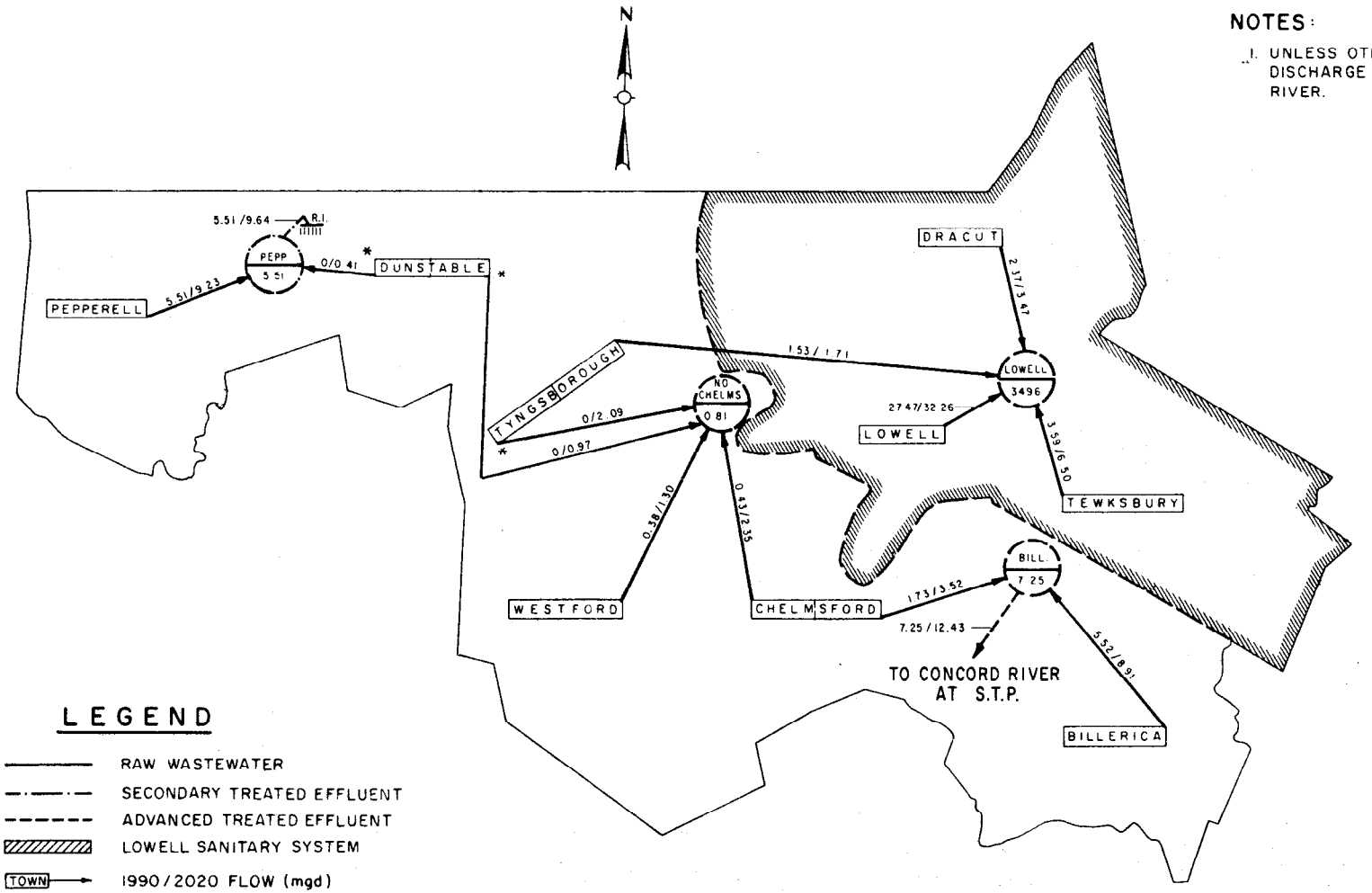

N
NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
5.51/9.64
R.I.
PEPP
5.51
0/0.41
DUNSTABLE
PEPPERELL
5.51/9.23
DRACUT
2.37/3.47
1.53/1.71
LOWELL
3496
TYNGSBOROUGH
NO CHELMS
0.81
0/2.09
0/0.97
27.47/32.26
LOWELL
3.59/6.50
TEWKSBURY
0.38/1.30
0.43/2.55
BILL.
7.25
1.73/3.52
WESTFORD
CHELMSFORD
7.25/12.43
TO CONCORD RIVER AT S.T.P.
5.52/8.91
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN 1990 FLOW IN MGD
TREATMENT PLANT LOCATION
SPRAY IRRIGATION OR RAPID INFILTRATION
* THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
LEAST COST ALTERNATE
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 15

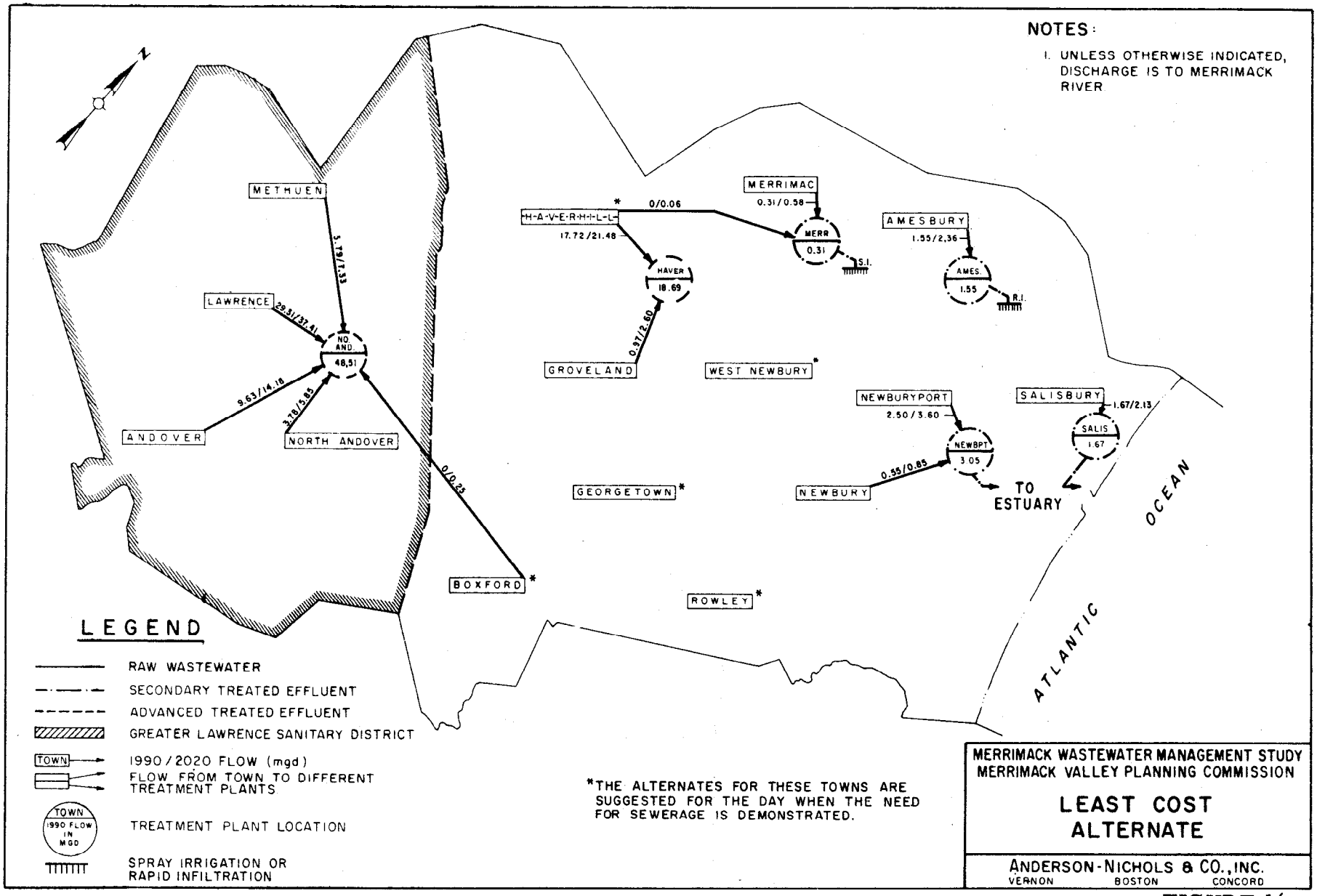

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER
METHUEN
5.79/7.33
LAWRENCE
29.51/37.41
NO. AND.
48.51
ANDOVER
9.63/14.18
3.78/5.85
NORTH ANDOVER
0/0.23
BOXFORD*
HAVERHILL
*
0/0.06
17.72/21.48
HAVER
18.69
0.97/2.60
GROVELAND
MERRIMAC
0.31/0.58
MERR
0.31
S.I.
WEST NEWBURY*
AMESBURY
1.55/2.36
AMES.
1.55
R.I.
NEWBURYPORT
2.50/3.60
NEWBPT
3.05
0.55/0.85
NEWBURY
GEORGETOWN*
SALISBURY
1.67/2.13
SALIS
1.67
TO ESTUARY
OCEAN
ATLANTIC
ROWLEY*
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN 1990 FLOW IN MGD
TREATMENT PLANT LOCATION
SPRAY IRRIGATION OR RAPID INFILTRATION
*THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
LEAST COST ALTERNATE
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 16

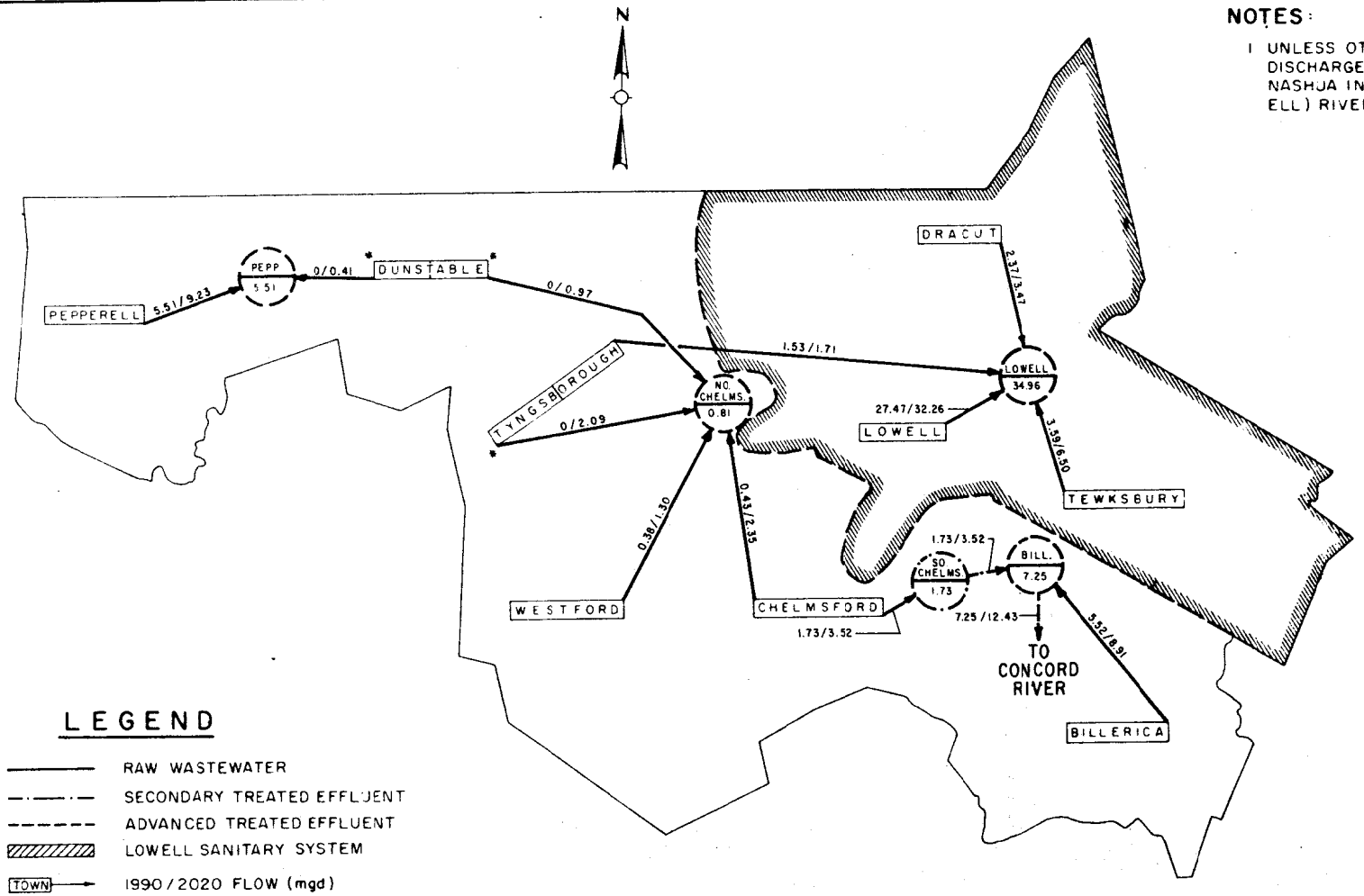

N
NOTES:
1 UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER.
PEPPERELL
5.51/9.23
PEPP
5.51
0/0.41
DUNSTABLE
0/0.97
TYNGSBOROUGH
0/2.09
1.53/1.71
NO. CHELMS.
0.81
DRACUT
2.37/3.47
LOWELL
34.96
27.47/32.26
LOWELL
3.59/6.50
TEWKSBURY
WESTFORD
0.38/1.30
0.43/2.35
CHELMSFORD
1.73/3.52
1.73/3.52
SO CHELMS.
1.73
BILL.
7.25
7.25/12.43
5.52/8.91
TO CONCORD RIVER
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
* THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
NMAC
DRAFT PREFERRED PLAN
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 17

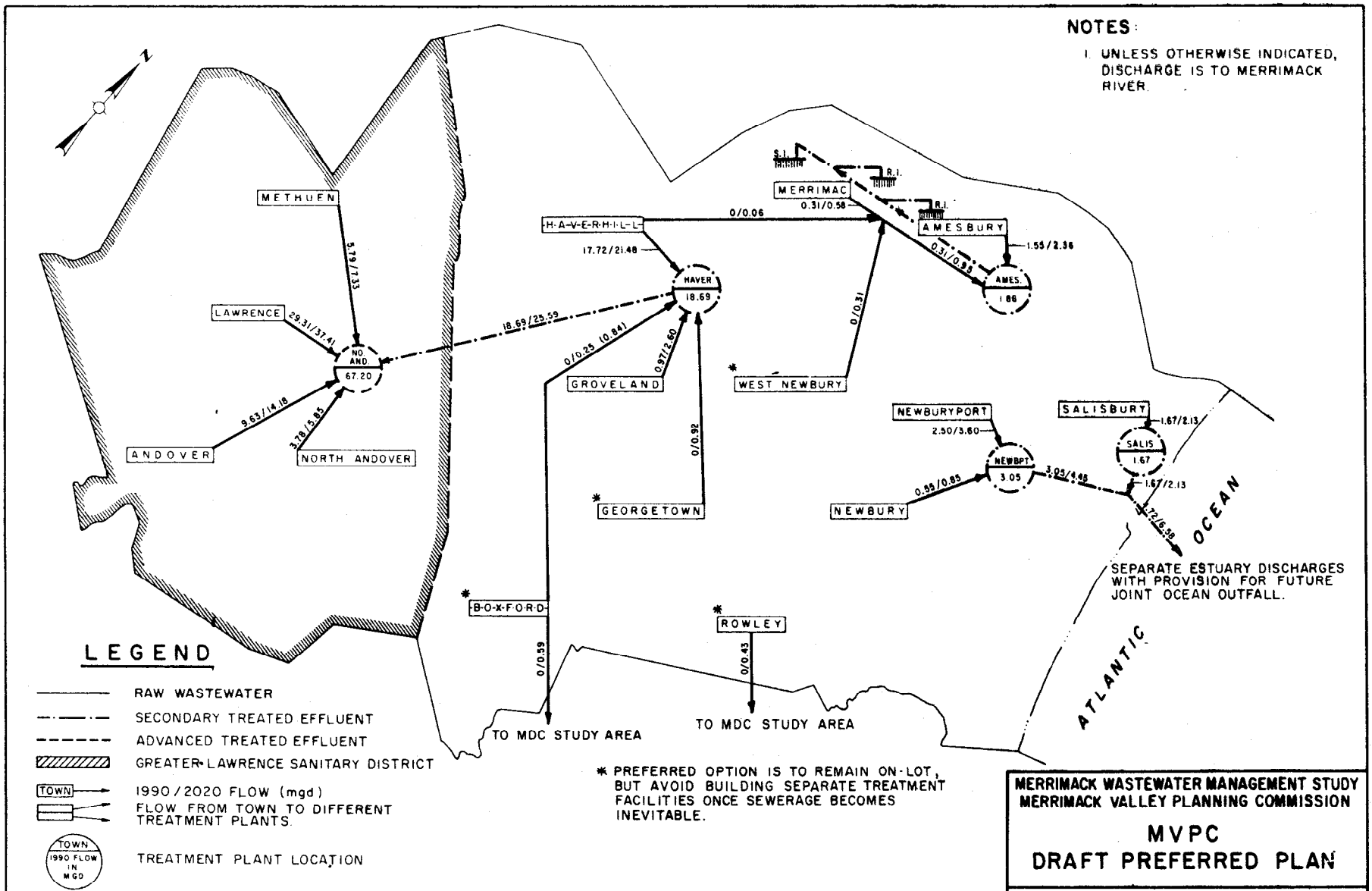

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
METHUEN
5.79/7.33
LAWRENCE
29.31/37.41
NO. AND.
67.20
18.69/25.59
HAVER
18.69
H-A-V-E-R-H-I-L-L
0/0.06
17.72/21.48
MERRIMAC
0.31/0.58
AMESBURY
1.55/2.36
0.31/0.95
AMES.
1.86
0/0.31
WEST NEWBURY
0/0.25 (0.84)
0.97/2.60
GROVELAND
0/0.92
GEORGETOWN
ANDOVER
9.63/14.18
3.78/5.85
NORTH ANDOVER
NEWBURYPORT
2.50/3.60
NEWBPT
3.05
3.05/4.45
SALISBURY
1.67/2.13
SALIS
1.67
1.67/2.13
0.55/0.85
NEWBURY
3.72/5.58
OCEAN
SEPARATE ESTUARY DISCHARGES WITH PROVISION FOR FUTURE JOINT OCEAN OUTFALL.
B-O-X-F-O-R-D
0/0.59
ROWLEY
0/0.43
TO MDC STUDY AREA
TO MDC STUDY AREA
ATLANTIC
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS.
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
* PREFERRED OPTION IS TO REMAIN ON-LOT, BUT AVOID BUILDING SEPARATE TREATMENT FACILITIES ONCE SEWERAGE BECOMES INEVITABLE.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
MVPC
DRAFT PREFERRED PLAN
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 18

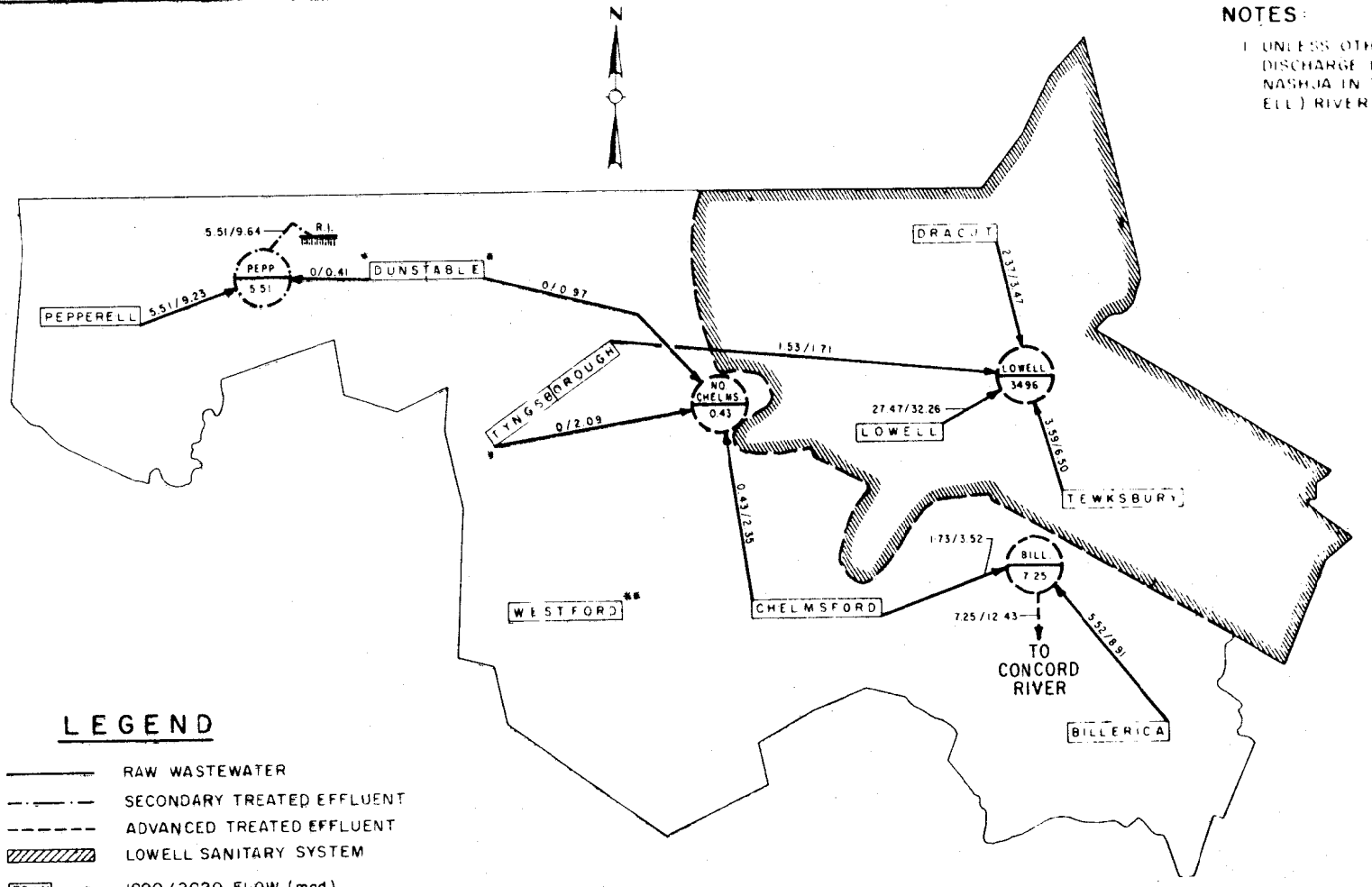

N
NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK (OR NASHUA IN THE CASE OF PEPPERELL) RIVER
5.51/9.64
R.I.
PEPP
5.51
0/0.41
DUNSTABLE
0/0.97
PEPPERELL
5.51/9.23
TYNGSBOROUGH
0/2.09
NO CHELMS
0.43
1.53/1.71
DRACUT
2.37/3.47
LOWELL
34.96
27.47/32.26
LOWELL
3.59/6.50
TEWKSBURY
0.43/2.35
1.73/3.52
BILL
7.25
WESTFORD**
CHELMSFORD
7.25/12.43
TO CONCORD RIVER
5.52/8.91
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
* THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
** PREFERRED OPTION IS TO REMAIN ON-LOT WITH NO PROVISIONS FOR FUTURE SEWERAGE.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
IMPACT PLAN
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 19

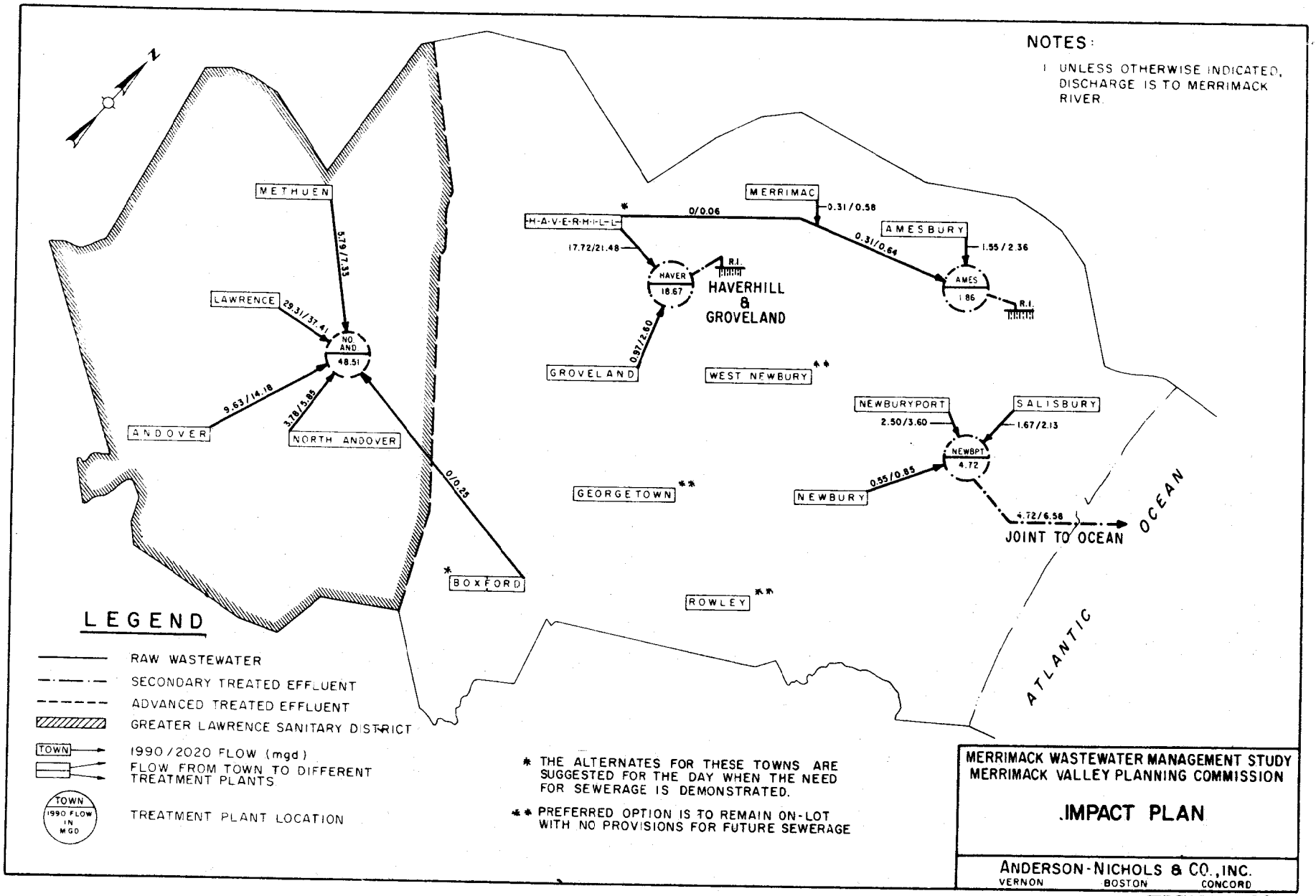

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
METHUEN
5.19/7.93
LAWRENCE
29.31/37.41
NO AND
48.51
9.63/14.18
ANDOVER
3.78/5.85
NORTH ANDOVER
0/0.25
BOXFORD*
H-A-V-E-R-H-I-L-L*
0/0.06
MERRIMAC
0.31/0.58
AMESBURY
1.55/2.36
17.72/21.48
HAVER
18.67
R.I.
HAVERHILL & GROVELAND
0.31/0.64
AMES
1.86
R.I.
0.97/2.60
GROVELAND
WEST NEWBURY**
NEWBURYPORT
2.50/3.60
SALISBURY
1.67/2.13
NEWBPT
4.72
0.55/0.85
NEWBURY
GEORGETOWN**
4.72/6.58
JOINT TO OCEAN
OCEAN
ATLANTIC
ROWLEY**
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
* THE ALTERNATES FOR THESE TOWNS ARE SUGGESTED FOR THE DAY WHEN THE NEED FOR SEWERAGE IS DEMONSTRATED.
** PREFERRED OPTION IS TO REMAIN ON-LOT WITH NO PROVISIONS FOR FUTURE SEWERAGE
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
IMPACT PLAN
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 20

The Regional Planning Agencies Draft Preferred Plan (based on public evaluation of the alternatives), the Least Cost Plan (developed by the engineering consultant and based on minimizing the construction and operation and maintenance costs), the Impact Plan (developed to maximize socio-economic, recreational, aesthetic, and hygienic benefits) and the impact reports on the original eleven alternatives then became the subject of a two-day workshop for the members of the Technical Subcommittee.

The purpose of the two-day workshop was to evaluate all the plans that had been prepared together with the impact reports and the knowledge gained from the public and attempt to select or develop a preferred plan while focusing all significant issues for policy review associated with the selected plan. The plan developed at the two-day workshop became known as the "draft cost effect plan" or the "draft recommended plan."

One of the major problems at the two-day workshop was all study team members had not had sufficient time to review the various impact reports. The reports themselves were in draft form and many of the conclusions and statements were questionable without verification or modification. The impact reports were voluminous and the capability of the participants to absorb all that had transpired or been printed within the previous 8 months was a determining factor in the generation of a recommendation. Although each impact consultant gave a 30-45 minute presentation on their significant findings, some subcommittee members were apprehensive feeling sufficient information was not available to make a recommendation. If all impact reports could have been distributed, reviewed and modified prior to the two-day workshop, the anxieties would have been reduced and the initial recommendations made with a better sense of security.

Additional meetings reconsidering the impact reports findings and further public scrutiny of the "draft recommended plan" were warranted before the recommended plan could be finalized. The "draft cost-effective plan" was presented for review and critique during the third set of public meetings. In all but a few communities, the draft plan met general acceptance. Elected officials and representatives of communities with concerns over the cost-effective plan were asked to meet with the Technical Subcommittee to express their views. The knowledge gained by the members of the subcommittee during the forums with local elected officials necessitated a re-evaluation of the impacts and initial recommendations. That second re-evaluation resulted in the recommended plan found in Figures 21 and 22.

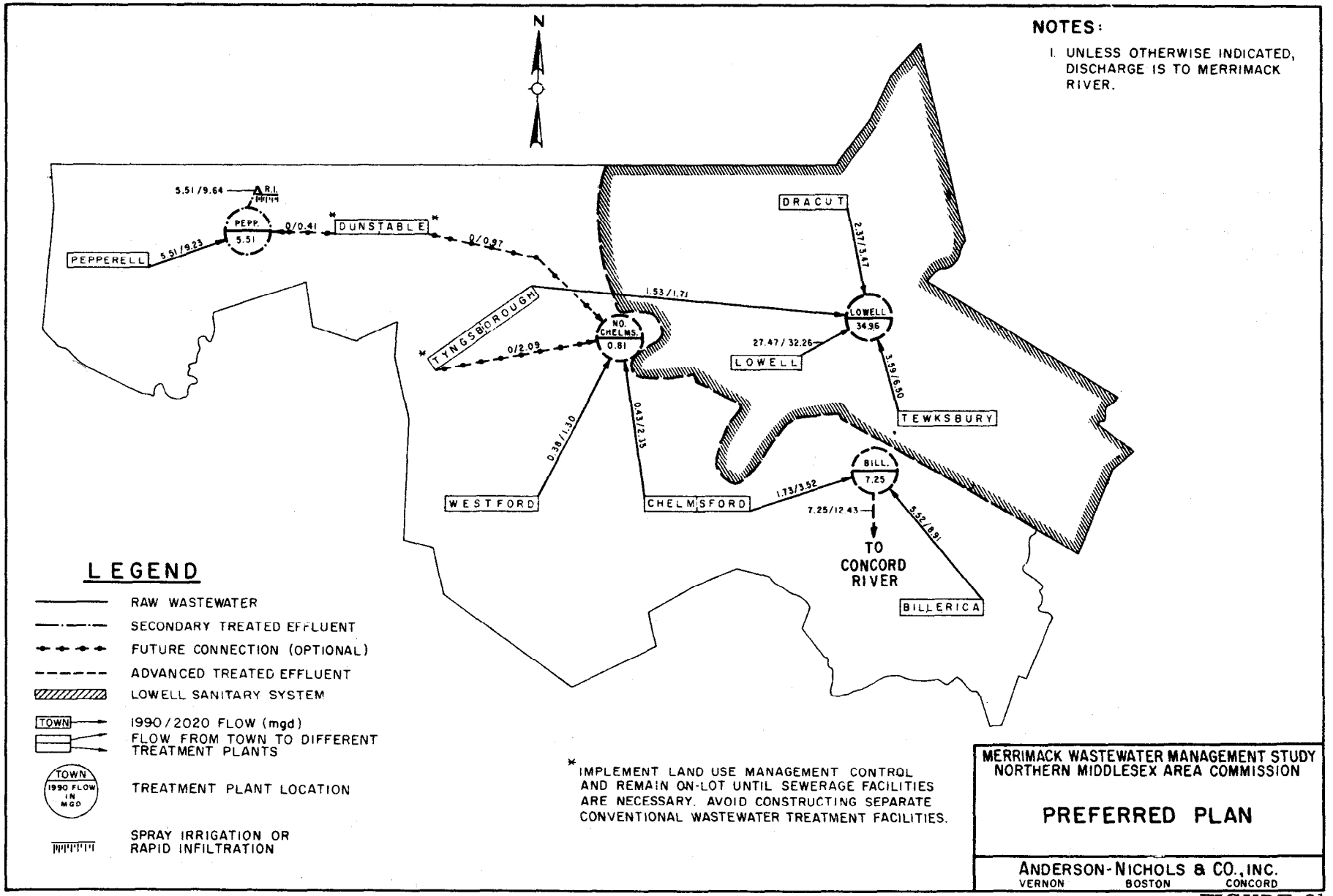

N
NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
5.51/9.64
R.I.
PEPP.
5.51
PEPPERELL
5.51/9.23
0/0.41
DUNSTABLE
0/0.97
TYNGSBOROUGH
0/2.09
1.53/1.71
NO. CHELMS.
0.81
DRACUT
2.37/3.47
LOWELL
34.96
27.47/32.26
LOWELL
3.99/6.50
TEWKSBURY
0.38/1.30
WESTFORD
0.43/2.35
CHELMSFORD
BILL.
7.25
1.73/3.52
7.25/12.43
5.52/8.91
TO CONCORD RIVER
BILLERICA
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
FUTURE CONNECTION (OPTIONAL)
ADVANCED TREATED EFFLUENT
LOWELL SANITARY SYSTEM
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS
TOWN
1990 FLOW IN MGD
TREATMENT PLANT LOCATION
SPRAY IRRIGATION OR RAPID INFILTRATION
* IMPLEMENT LAND USE MANAGEMENT CONTROL AND REMAIN ON-LOT UNTIL SEWERAGE FACILITIES ARE NECESSARY. AVOID CONSTRUCTING SEPARATE CONVENTIONAL WASTEWATER TREATMENT FACILITIES.
MERRIMACK WASTEWATER MANAGEMENT STUDY
NORTHERN MIDDLESEX AREA COMMISSION
PREFERRED PLAN
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 21

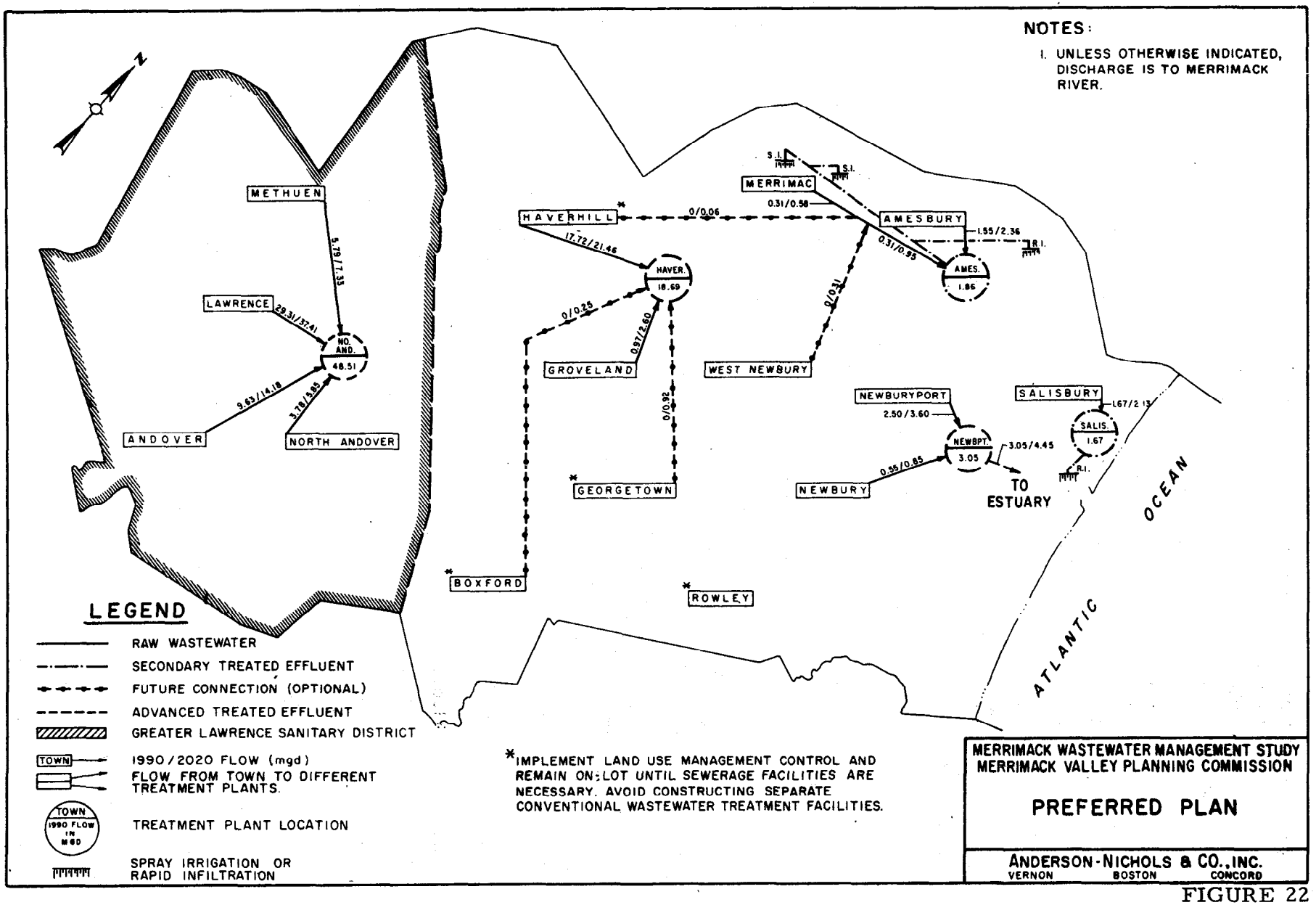

NOTES:
1. UNLESS OTHERWISE INDICATED, DISCHARGE IS TO MERRIMACK RIVER.
N
METHUEN
5.79/7.33
LAWRENCE
29.31/37.41
NO. AND.
48.51
9.63/14.18
3.78/3.85
ANDOVER
NORTH ANDOVER
HAVERHILL
0/0.06
17.72/21.46
HAVER
18.69
0/0.25
0.97/2.60
GROVELAND
0/0.92
GEORGETOWN
BOXFORD
ROWLEY
S.I.
MERRIMAC
0.31/0.58
AMESBURY
1.55/2.36
R.I.
0.31/0.95
AMES.
1.86
0/0.31
WEST NEWBURY
NEWBURYPORT
2.50/3.60
NEWBPT.
3.05
3.05/4.45
TO ESTUARY
0.55/0.85
NEWBURY
SALISBURY
1.67/2.13
SALIS.
1.67
R.I.
OCEAN
ATLANTIC
LEGEND
RAW WASTEWATER
SECONDARY TREATED EFFLUENT
FUTURE CONNECTION (OPTIONAL)
ADVANCED TREATED EFFLUENT
GREATER LAWRENCE SANITARY DISTRICT
TOWN
1990/2020 FLOW (mgd)
FLOW FROM TOWN TO DIFFERENT TREATMENT PLANTS.
TOWN 1990 FLOW IN MGD
TREATMENT PLANT LOCATION
SPRAY IRRIGATION OR RAPID INFILTRATION
*IMPLEMENT LAND USE MANAGEMENT CONTROL AND REMAIN ON-LOT UNTIL SEWERAGE FACILITIES ARE NECESSARY. AVOID CONSTRUCTING SEPARATE CONVENTIONAL WASTEWATER TREATMENT FACILITIES.
MERRIMACK WASTEWATER MANAGEMENT STUDY
MERRIMACK VALLEY PLANNING COMMISSION
PREFERRED PLAN
ANDERSON-NICHOLS & CO., INC.
VERNON BOSTON CONCORD

FIGURE 22

F. SUMMARY OF IMPACTS

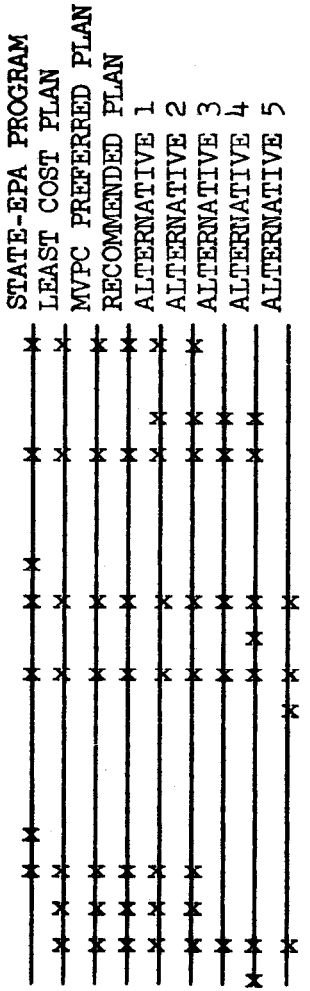
The following pages provide a summary of the impacts utilized in the evaluation of the various wastewater management alternatives. The summaries indicate the potential biological, aesthetic, hygienic, socio-economic and engineering impacts that may result from the implementation of each alternative. The information also shows for each different geographical area whether the designated impacts are adverse or beneficial in nature and if they are anticipated to be of long or short-term duration.

In reviewing the summary of impacts, as well as any of the impact information in the report, it should be remembered that the impacts are based upon "conceptual" type engineering designs and not on final construction plans where complete engineering details are given and exact location of plant facilities, pipelines, etc. are shown. This will explain why many of the impact findings are in general terms and given broad explanations.

SUMMARY OF IMPACTS

Geographical Area Lowell-Dracut-Tewksbury-Eastern Tyngsborough

-L - Adverse impact - long term*
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact.



Aesthetic

(+L) Flow augmentation of Merrimack River will improve visual quality during low flow periods.
(- S) Transmission systems impact on natural environment.
(+L) Potential recreational corridors along transmission lines. Supportive of regional land use plans and possible interface with Lowell Urban National Cultural Park.
(+L) Improved visual quality of Merrimack River.
(+L) Treatment plant design could accommodate need for river access point.
(-L) Reduction of instream flow between Lowell and Lawrence.
(-L) Natural riverscape at Duck Island will be destroyed.
(-L) Rapid infiltration sites effect on landscape quality.

Biological

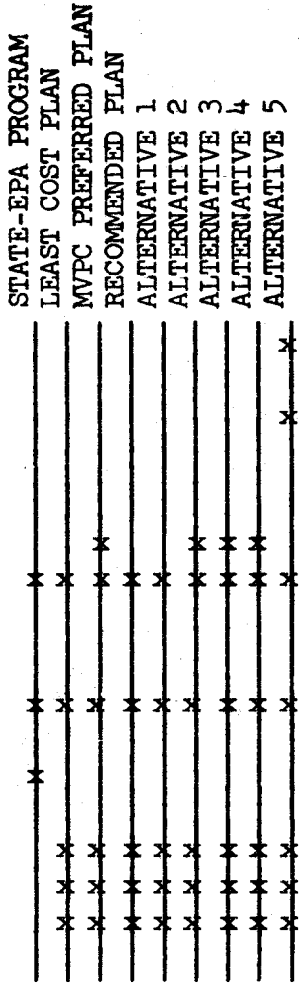
(-L) Nutrients in Merrimack River may exceed acceptable limits.
(-L) Potential residual chlorine toxicities to aquatic organisms.
(+L) Flow augmentation will enhance aquatic life during low flow periods.
(+L) Water quality improved to acceptable limits.
(-L) Impact on aquatic life between Lowell and Lawrence.

* In a number of cases, the designations of adverse or beneficial and long or short-term may be subject to question. The designations associated with the impacts are the best judgments of the authors.

SUMMARY OF IMPACTS

Geographical Area Lowell-Dracut-Tewksbury-Eastern Tyngsborough

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact.



Biological (cont'd)

(+L) Due to buffering capabilities of land, discharge to land preferred over discharge to receiving stream.

(+L) Recharge of groundwater aquifers.

Engineering

(+L) Large facility could realize improved operational efficiency.

(-L) Site expansion capabilities.

Socio-Economic

(+L) Sewer service area would encourage development consistent with economic goals in Tewksbury and Lowell.

(-L) Excessive concentrations of nutrients in Merrimack River will limit recreational benefits.

(+L) Advanced treatment may permit increased recreational pursuits.

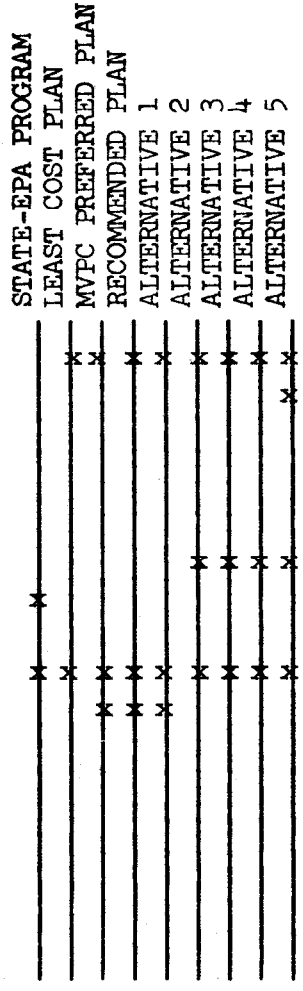
(- S) Local traffic patterns effected during construction of collection systems.

(+L) Service sector associated with recreational pursuits will increase with improved water quality.

SUMMARY OF IMPACTS

Geographical Area Lowell-Dracut-Tewksbury-Eastern Tyngsborough

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact.



Socio-Economic (cont'd)

(-L) Sewer service areas compatibility with regional and local land use plans.
(-L) 460 acres of land in Lancaster, 200 acres in Groton and 150 acres in Westford removed from tax roles.

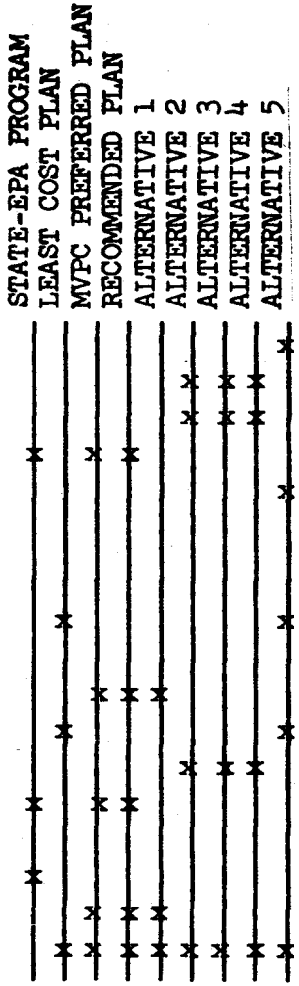
Hygienic

(-L) Transmission lines subject to leakage and pump failures.
(-L) Trace metals in fish flesh, which presently exceed safe standards for human consumption, will continue to biomagnify through the food chain.
(-L) Ineffective virus removal with chlorination.
(+L) Advanced treatment will remove substances that can interfere with disinfection.

SUMMARY OF IMPACTS

Geographical Area Chelmsford-Western Tyngsborough-Eastern Dunstable

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact.



Aesthetic

(-L) 435 acres of rapid infiltration sites effect landscape quality.
(- S) Transmission systems impact on natural environment.
(+L) Potential recreational corridors along transmission lines.
(+L) Rural character of Dunstable and West Tyngsborough maintained.
(+L) 180-acre spray irrigation site in Chelmsford maintains open space.

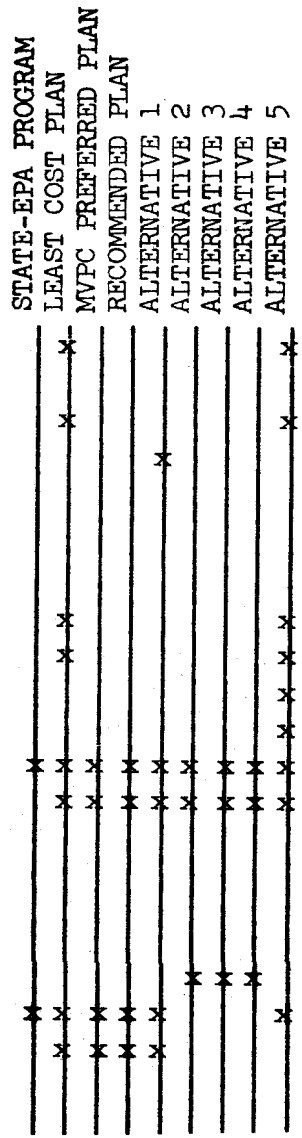
Biological

(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.
(-L) Potential residual chlorine toxicities to aquatic organisms.
(+L) Recharge of groundwater aquifers.
(-L) Flow of local feeder streams.
(+L) Individual septic systems maintain flow of feeder streams in Western Tyngsborough and Eastern Dunstable.
(-L) Nutrients in Merrimack River may exceed acceptable limits.
(-L) Potential residual chlorine toxicities to aquatic organisms.
(+L) Water quality improved to acceptable limits.

SUMMARY OF IMPACTS

Geographical Area Chelmsford-Western Tyngsborough-Eastern Dunstable

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Engineering

(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.
(+L) Land systems more likely to consistently achieve design capability.
(-L) Operation and maintenance economies.

Socio-Economic

(-L) Treatment site compatibility with future land use plans.
(-L) 210 acres removed from roles of taxable land in Tyngsborough.
(-L) 225 acres removed from roles of taxable land in Dunstable.
(-L) 180 acres removed from roles of taxable land in Chelmsford.
(- S) Transmission line construction effect on local traffic patterns.
(+L) Service sector associated with recreational pursuits will increase with improved water quality.

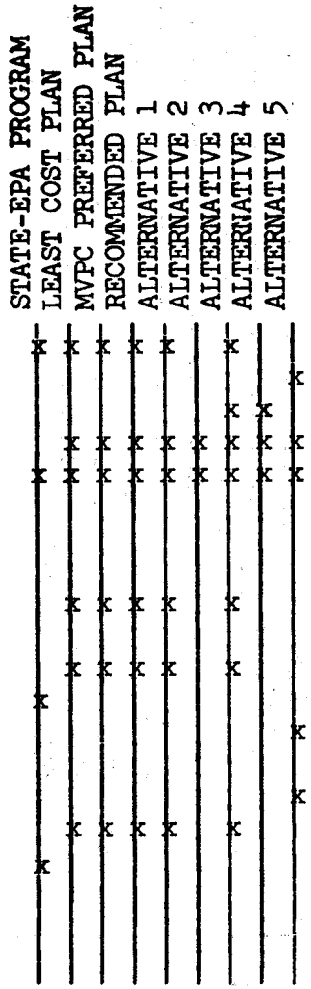
Hygienic

(-L) Transmission lines subject to leakage and pump failures.
(-L) Ineffective virus removal with chlorination.
(+L) Advanced treatment will remove substances that can interfere with disinfection.

SUMMARY OF IMPACTS

Geographical Area Billerica

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+ S - Beneficial impact - short term
Blank spaces imply no discernable impact



Aesthetic

(+L) Flow augmentation of Concord River during low flow periods.
(-L) 340-acre rapid infiltration site effect on landscape quality.
(-S) Transmission systems impact on natural environment.
(+L) Potential recreational corridors along transmission lines.
(+L) Treatment plant design could accommodate need for river access point.

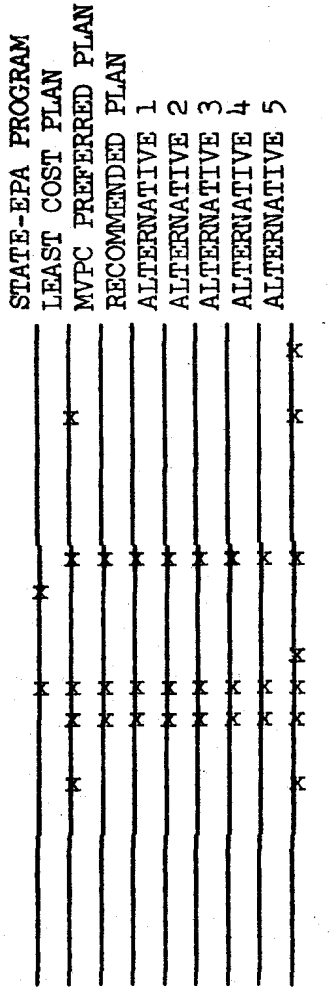
Biological

(-L) Treatment plant failure would have a substantial impact on aquatic life of Concord River.
(-L) Residual chlorine, chloramines and ammonia may exceed acceptable limits.
(-L) Nutrients in Concord River will exceed acceptable limits.
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.
(+L) Recharge of groundwater aquifers in Concord-Carlisle area.
(+L) Flow augmentation will enhance aquatic life during low flow periods.
(-L) Mercury concentrations effect on game fish species.

SUMMARY OF IMPACTS

Geographical Area Billerica

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Engineering

(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.

(+L) Land systems more likely to consistently achieve design capability.

Socio-Economic

(+L) Sewer service areas compatible with regional land use plans.

(-L) Excessive concentrations of nutrients in Concord River will limit recreational benefits.

(-L) 340 acres removed from roles of taxable land in Concord and Carlisle.

(-S) Local traffic patterns effected during construction of collection systems.

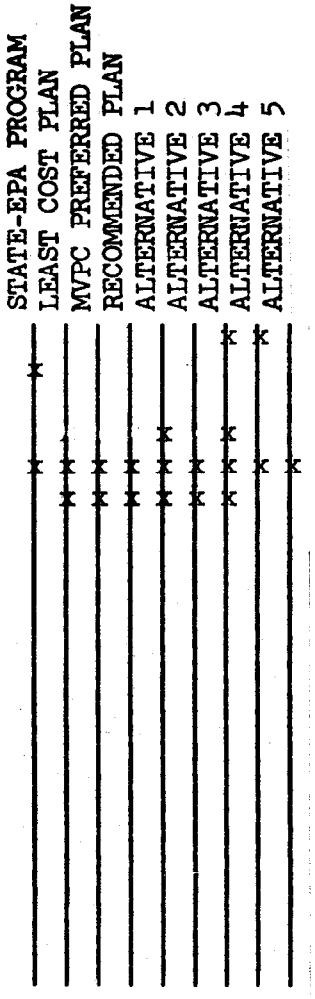
(+L) Service sector associated with recreational pursuits will increase with improved water quality.

(+L) Treatment site in proposed industrial development area would support goals for economic development.

SUMMARY OF IMPACTS

Geographical Area Billerica

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



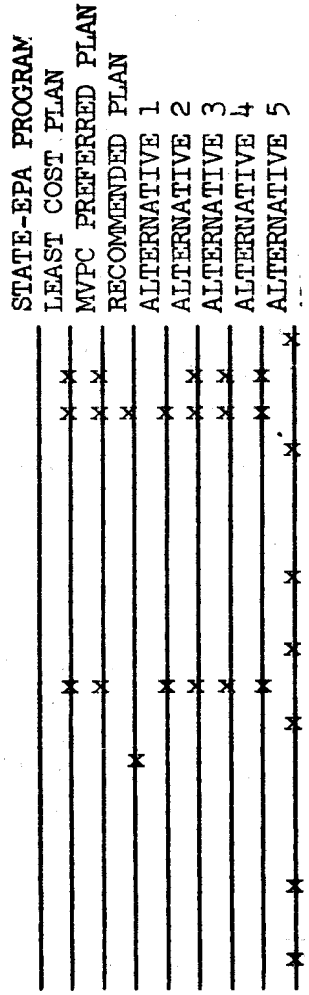
Hygienic

(-L) Transmission lines subject to leakage and pump failures.
(-L) Trace metals in fish flesh, which presently exceed safe standards for human consumption, will continue to biomagnify through the food chain.
(-L) Effluent discharge above Billerica water supply intake.
(-L) Ineffective virus removal with chlorination.
(+L) Advanced treatment will remove substances that can interfere with disinfection.

SUMMARY OF IMPACTS

Geographical Area Westford

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Aesthetic

(-L) 150-acre rapid infiltration system effect on landscape quality.
(- S) Transmission systems impact on natural environment.
(+L) Potential recreational corridors along transmission lines.
(+L) 620-acre spray irrigation system maintains open space.

Biological

(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.
(+L) Recharge of groundwater aquifers.
(-L) Flow of local feeder streams.
(+L) Nutrients in wastewater utilized by agricultural crops.
(+L) Individual septic systems maintain flow in local feeder streams.

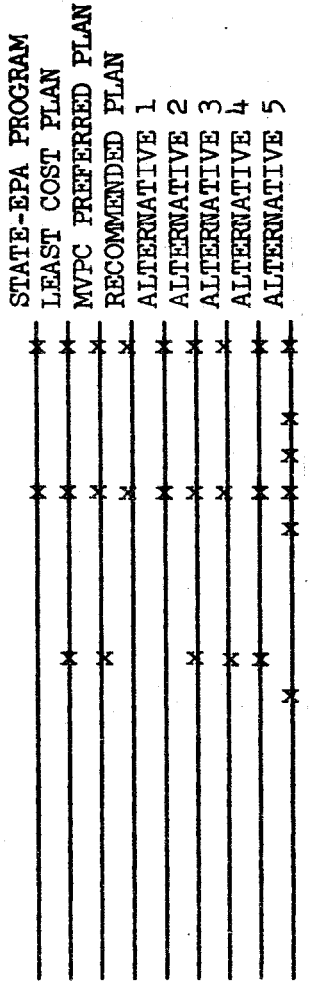
Engineering

(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.
(-L) Operation and maintenance economies.

SUMMARY OF IMPACTS

Geographical Area Westford

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Socio-Economic

(-L) Sewer service compatibility with planned industrial, commercial, and residential areas.
(+L) Economic return on crops harvested.
(-L) 770 acres removed from roles of taxable land.
(- S) Local traffic patterns effected during construction of collection systems.
(-L) Rapid infiltration site conflicts with future land use plans.

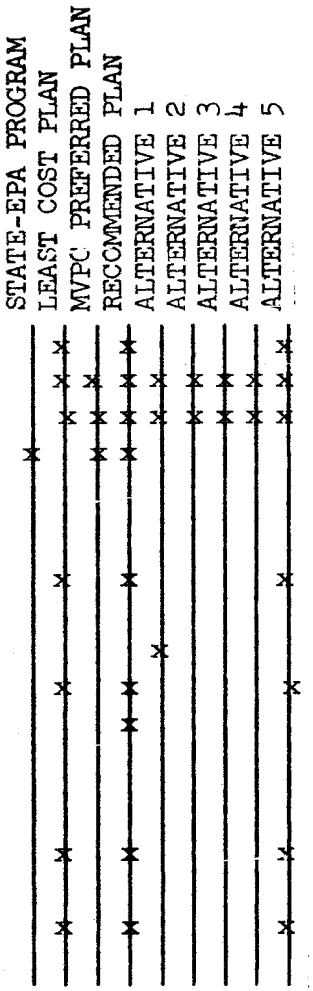
Hygienic

(-L) Transmission lines subject to leakage and pump failures.
(-L) Ineffective virus removal with chlorination.

SUMMARY OF IMPACTS

Geographical Area Pepperell-Western Dunstable

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Aesthetic

(-L) 320-acre rapid infiltration system effect on landscape quality.
(- S) Transmission system impact on natural environment.
(+L) Potential recreational corridors along transmission lines.
(+L) Rural character of Dunstable maintained.

Biological

(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.
(-L) Potential residual chlorine toxicities to aquatic organisms.
(+L) Recharge of groundwater aquifers.
(+L) Individual septic systems maintain flow in feeder streams.

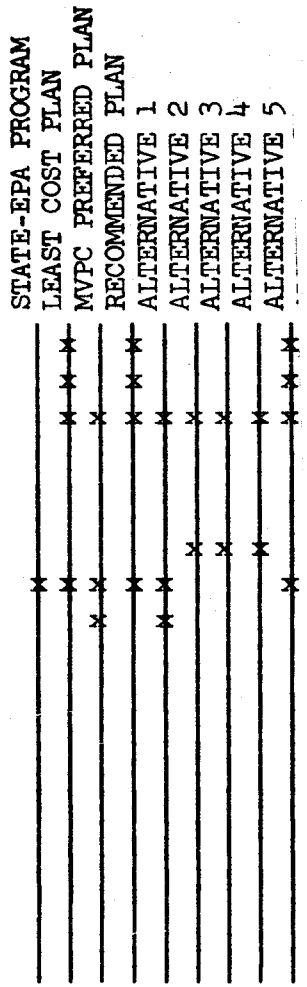
Engineering

(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.
(+L) Land systems more likely to consistently achieve design capability.

SUMMARY OF IMPACTS

Geographical Area Pepperell-Western Dunstable

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Socio-Economic

(-L) Rapid infiltration site conflicts with land use plans.
(-L) 320 acres removed from roles of taxable land.
(-L) Sewer service in low density area might create development pressures.

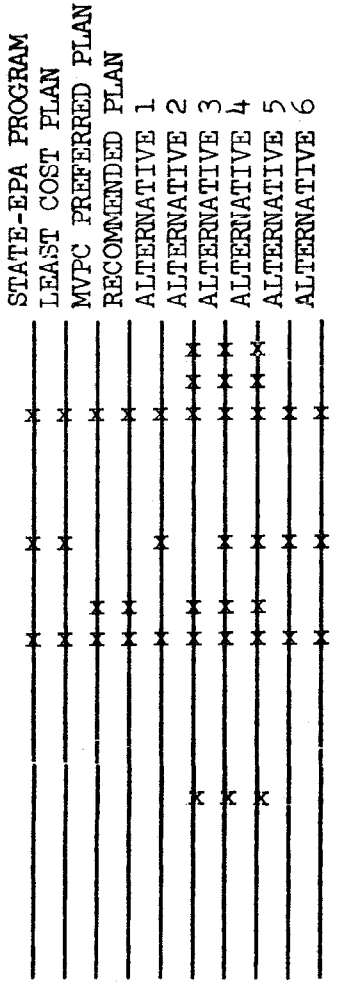
Hygienic

(-L) Transmission lines subject to leakage and pump failures.
(-L) Ineffective virus removal with chlorination.
(+L) Advanced treatment plant will remove substances that interfere with disinfection.

SUMMARY OF IMPACTS

Geographical Area Newburyport-Newbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Aesthetic

(-S) Transmission systems impact on natural environment.
(+L) Potential recreational corridors along transmission lines.
(+L) Treatment plant design could accommodate need for river access point.

Biological

(-L) Ammonia, residual chlorine or chloramines may exceed acceptable limits in the Merrimack estuary.
(+L) Levels of toxic materials reduced.
(-L) Accumulation of toxic materials in shellfish would still be possible due to upstream discharges.

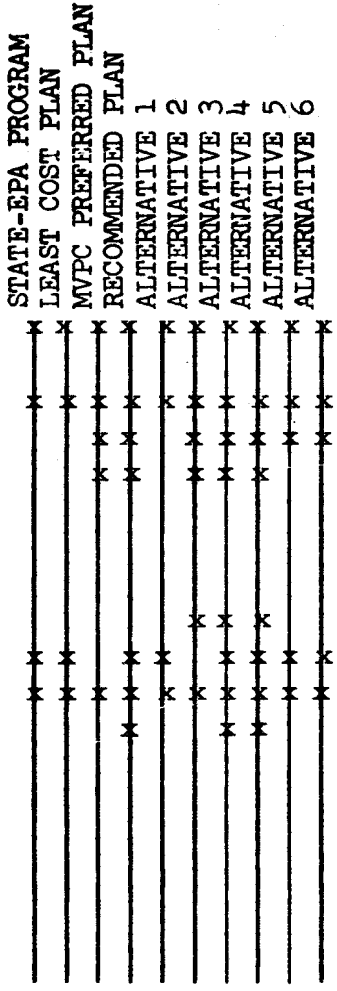
Engineering

(+L) Operation and maintenance of economies.

SUMMARY OF IMPACTS

Geographical Area Newburyport-Newbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Socio-Economic

(-L) Sewer service in low density area might create development pressures in Newburyport.
(-S) Local traffic patterns affected during construction of collection systems.
(+L) Service sector associated with recreational pursuits will increase.
(+L) Clam flats may be able to open.

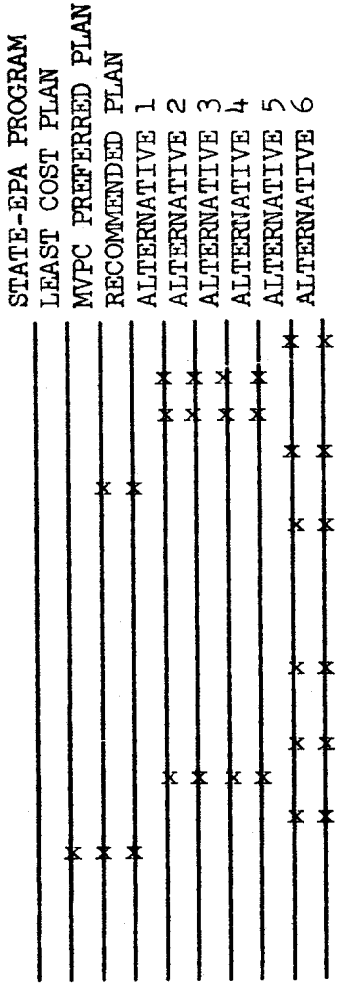
Hygienic

(-L) Transmission lines subject to leakage and pump failures.
(-L) Treatment plant failure will cause health hazard in harvesting clams.
(-L) Ineffective virus removal with chlorination.
(+L) Advanced waste treatment will remove substances that can interfere with disinfection.

SUMMARY OF IMPACTS

Geographical Area Georgetown

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Aesthetic

								X	X	(-L)	160-acre rapid infiltration system effect on landscape quality.
			X	X	X	X				(-S)	Transmission systems impact on natural environment.
			X	X	X	X				(+L)	Potential recreational corridors along transmission lines.
								X	X	(+L)	460-acre spray irrigation system maintains open space.
		X	X							(+L)	Rural character of town maintained.
								X	X	(+L)	Potential for recreational pursuits at spray irrigation sites.

Biological

								X	X	(+L)	Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.
								X	X	(+L)	Recharge of groundwater aquifers.
			X	X	X	X				(-L)	Flow of local feeder streams.
								X	X	(+L)	Nutrients in wastewater utilized by agricultural crops.
	X	X	X							(+L)	Individual septic systems maintain flow in feeder streams.

SUMMARY OF IMPACTS

Geographical Area Georgetown

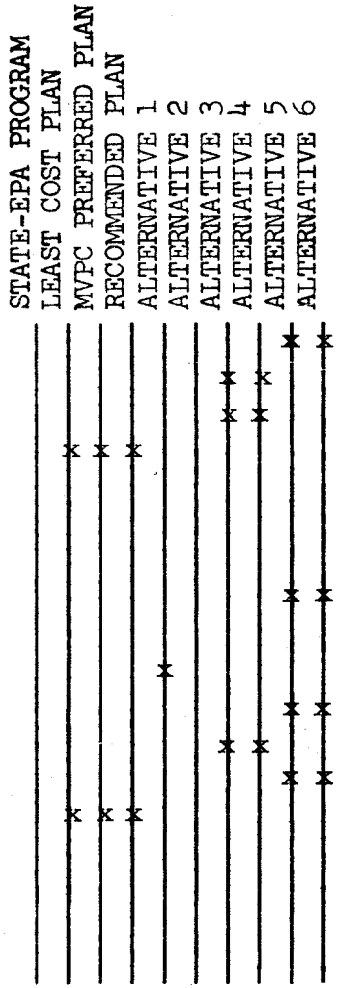
-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact

STATE-EPA PROGRAM	LEAST COST PLAN	MVPC PREFERRED PLAN	RECOMMENDED PLAN	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6		
								x	x		Engineering
								x	x	(+L)	Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.
								x	x	(-L)	Operation and maintenance economies.
								x	x	(+L)	Land systems more likely to consistently achieve design capability.
											Socio-Economic
								x	x	(-L)	Treatment site compatibility with open space plans.
x	x	x	x	x	x	x	x	x	x	(+L)	Sewer service areas supportive of regional land use plans.
								x	x	(+L)	Economic return on crops harvested.
								x	x	(-L)	620 acres removed from roles of taxable land.
											Hygienic
					x	x	x	x		(-L)	Transmission lines subject to leakage and pump failures.
					x	x	x	x		(+L)	Advanced waste treatment will remove substances that can interfere with disinfection.
x	x				x	x	x	x	x	(-L)	Ineffective virus removal with chlorination.

SUMMARY OF IMPACTS

Geographical Area Rowley

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Aesthetic

(+L) 320-acre spray irrigation system maintains open space.
(-S) Transmission systems impact on natural environment.
(+L) Potential recreational corridors along transmission lines.
(+L) Rural character of town maintained.

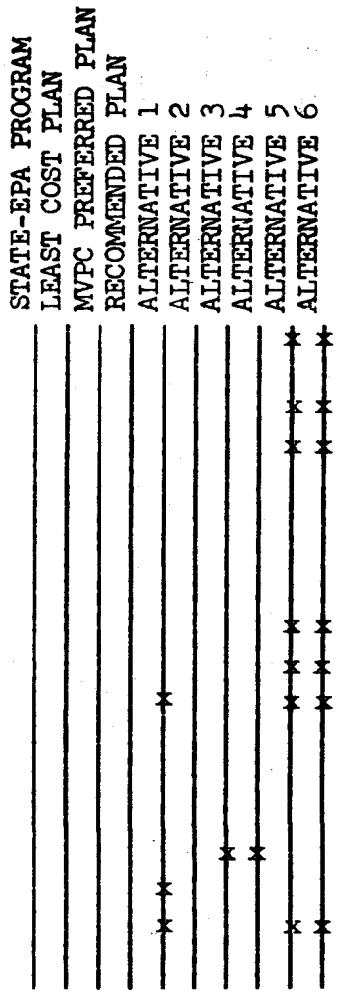
Biological

(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.
(-L) Potential residual chlorine toxicities to aquatic organisms in Rowley River.
(+L) Recharge of groundwater aquifers.
(-L) Flow of local feeder streams.
(+L) Nutrients in wastewater utilized agricultural crops.
(+L) Individual septic systems maintain flow in feeder streams.

SUMMARY OF IMPACTS

Geographical Area Rowley

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Engineering

(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.
(+L) Land systems more likely to consistently achieve design capability.
(-L) Operation and maintenance economies.

Socio-Economic

(+L) Economic return on crops harvested
(-L) 320 acres removed from roles of taxable land.
(-L) Treatment site compatibility with open space plans.

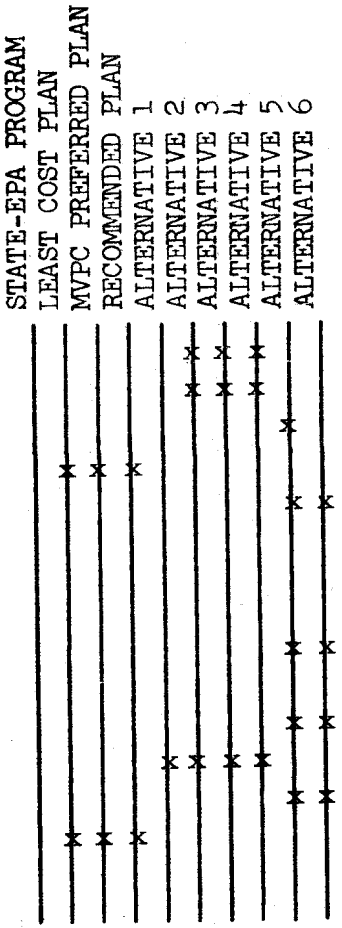
Hygienic

(-L) Transmission lines subject to leakage and pump failures.
(-L) Effluent discharge to Rowley River.
(-L) Ineffective virus removal with chlorination.

SUMMARY OF IMPACTS

Geographical Area West Newbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Aesthetic

(-S) Transmission systems impact on natural environment.
(+L) Potential recreational corridors along transmission lines.
(+L) Spray irrigation system maintains open space.
(+L) Rural character of town maintained.
(+L) Potential for recreational pursuits at spray irrigation sites.

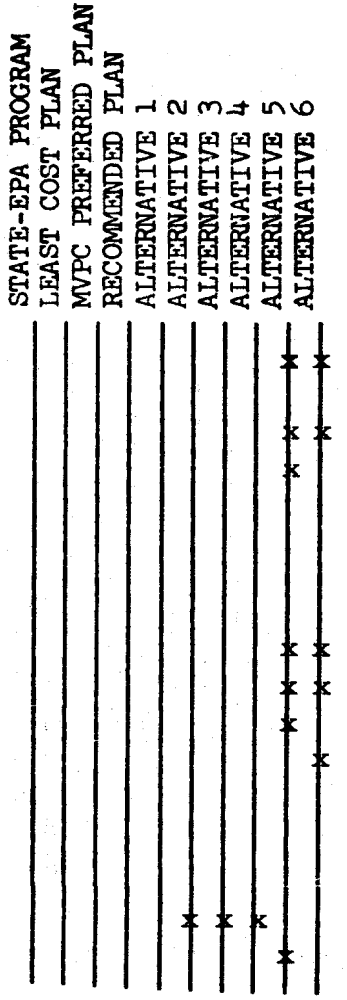
Biological

(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.
(+L) Recharge of groundwater aquifers.
(-L) Flow of local feeder streams.
(+L) Nutrients in wastewater utilized by agricultural crops.
(+L) Individual septic systems maintain flow in feeder streams.

SUMMARY OF IMPACTS

Geographical Area West Newbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Engineering

(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.
(+L) Land systems more likely to consistently achieve design capability.
(-L) Operation and maintenance economies.

Socio-Economic

(+L) Spray irrigation sites would support open space goals.
(+L) Economic return on crops harvested.
(-L) 270 acres removed from roles of taxable land.
(-L) 570 acres removed from roles of taxable land.

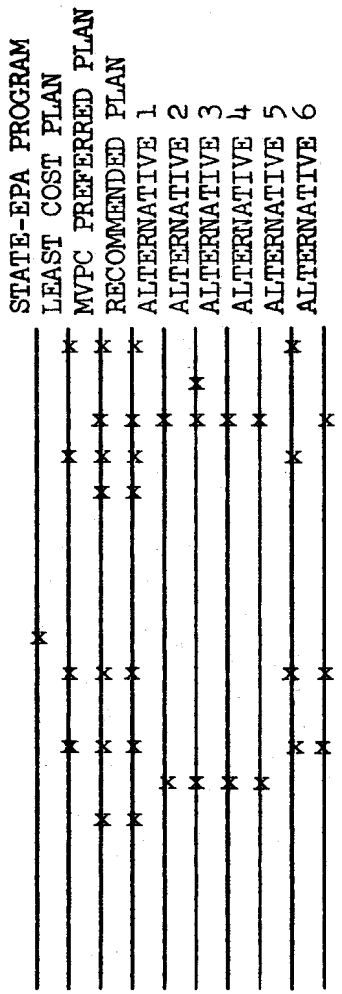
Hygienic

(-L) Transmission lines subject to leakage and pump failures.
(-L) Ineffective virus removal with chlorination.

SUMMARY OF IMPACTS

Geographical Area Merrimac

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Aesthetic

(+L) Spray irrigation system maintains open space.
(-S) Transmission systems impact on natural environment.
(+L) Potential recreational corridors along transmission lines.
(+L) Potential for recreational pursuits at spray irrigation sites.
(+L) Protection of Lake Attitash water quality.

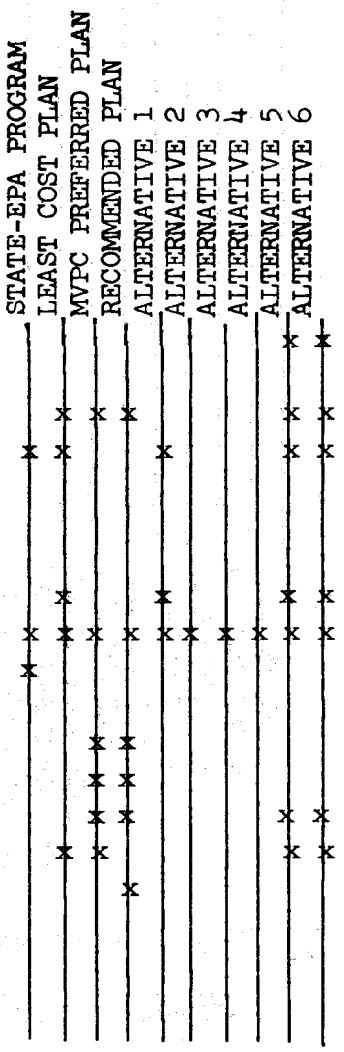
Biological

(-L) Nutrients in Merrimack River may exceed acceptable limits.
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.
(+L) Recharge of groundwater aquifers.
(-L) Regional configurations impact on instream flow.
(+L) Nutrients in wastewater utilized by agricultural crops.

SUMMARY OF IMPACTS

Geographical Area Merrimac

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Engineering

(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.
(+L) Land systems more likely to consistently achieve design capability.
(-L) Operation and maintenance economies.

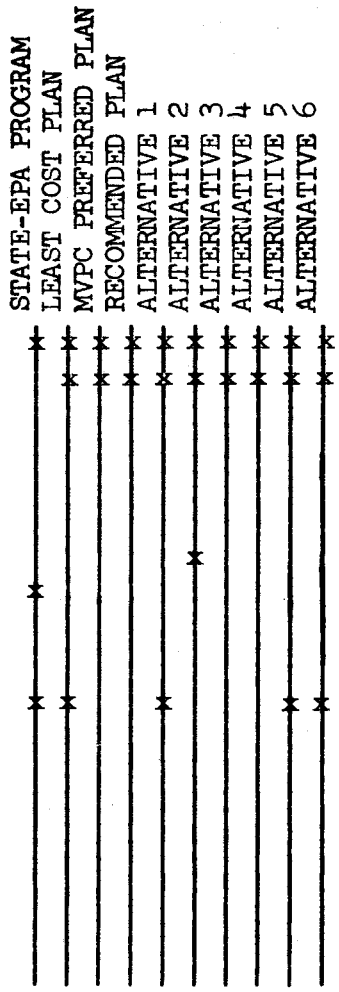
Socio-Economic

(-L) Treatment site compatibility with open space plans.
(+L) Sewer service area supports plans for medium and industrial development.
(-L) Excessive concentrations of nutrients in Merrimack River will limit recreational benefits.
(+L) Preserves future water supply.
(+L) Enhancement of recreation and industrial development.
(+L) Economic return on crops harvested.
(-L) 380 acres removed from roles of taxable land.
(-L) 250 acres removed from roles of taxable land.

SUMMARY OF IMPACTS

Geographical Area Merrimac

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Socio-Economic (Cont'd)

(-S) Local traffic patterns effected during construction of collection systems.

(+L) Service sector associated with recreational pursuits will increase with improved water quality.

Hygienic

(-L) Transmission lines subject to leakage and pump failures.

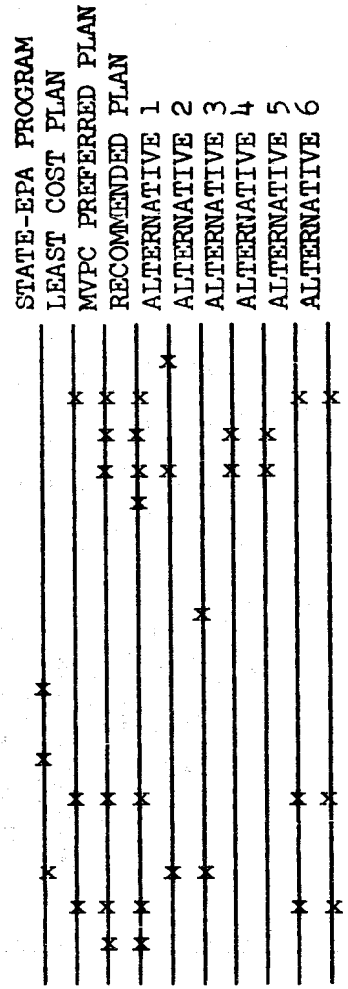
(-L) Trace metals in fish flesh, which presently exceed safe standards for human consumption, will continue to biomagnify through the food chain.

(-L) Ineffective virus removal with chlorination.

SUMMARY OF IMPACTS

Geographical Area Amesbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Aesthetic

(+L) Flow augmentation of Powwow River during low flow periods.
(-L) Rapid infiltration system effect on landscape quality.
(-S) Transmission systems impact on natural environment.
(+L) Potential recreational corridors along transmission lines.
(+L) Spray irrigation systems maintain open space.

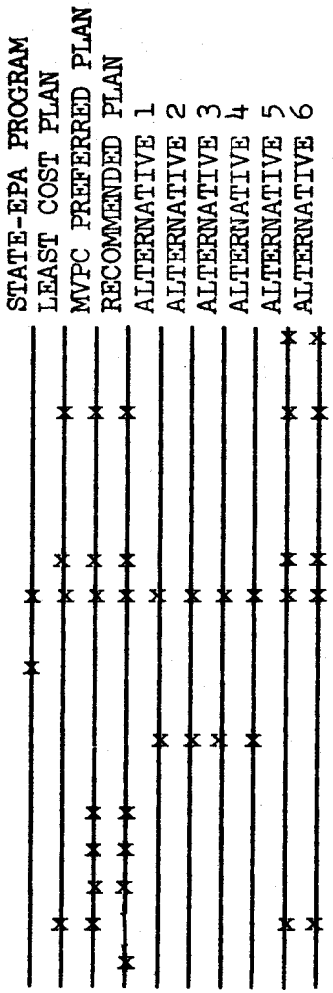
Biological

(+L) Flow augmentation of Powwow River will increase dissolved oxygen levels during low flow periods.
(+L) Removal of raw sewage discharges will significantly improve water quality of Powwow River.
(-L) Nutrients in Merrimack River may exceed acceptable limits.
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.
(-L) Potential residual chlorine toxicities to aquatic organisms.
(+L) Recharge of groundwater aquifers.
(+L) Nutrients in wastewater utilized by agricultural crops.

SUMMARY OF IMPACTS

Geographical Area Amesbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Engineering

(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.

(+L) Land systems more likely to consistently achieve design capability.

Socio-Economic

(-L) Treatment site compatibility with open space plans.

(-L) Sewer service in low density area might create pressure for development contrary to open space goals.

(-L) Excessive concentrations of nutrients in Merrimack River will limit recreational benefits.

(+L) Advanced treatment systems may permit increased recreational pursuits.

(+L) Preserves future water supply.

(+L) Enhancement of recreation and industrial development.

(+L) Economic return on crops harvested.

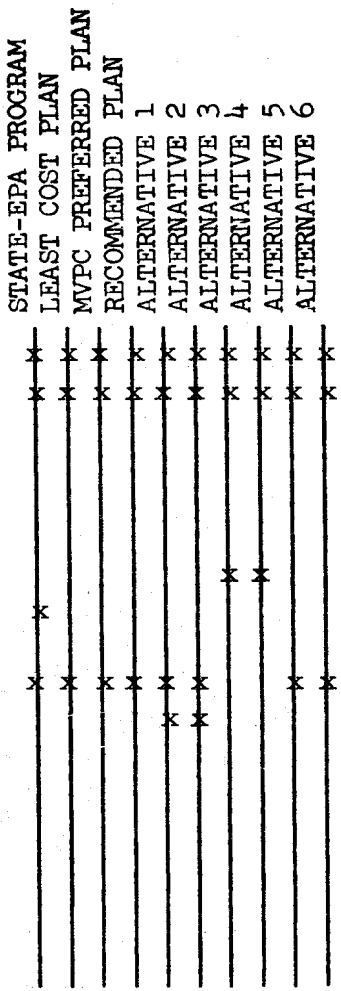
(-L) 80 acres removed from roles of taxable land.

(-L) 370 acres removed from roles of taxable land.

SUMMARY OF IMPACTS

Geographical Area Amesbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Socio-Economic (Cont'd)

(-S) Local traffic patterns affected during construction of collection systems.
(+L) Service sector associated with recreational pursuits will increase with improved water quality.

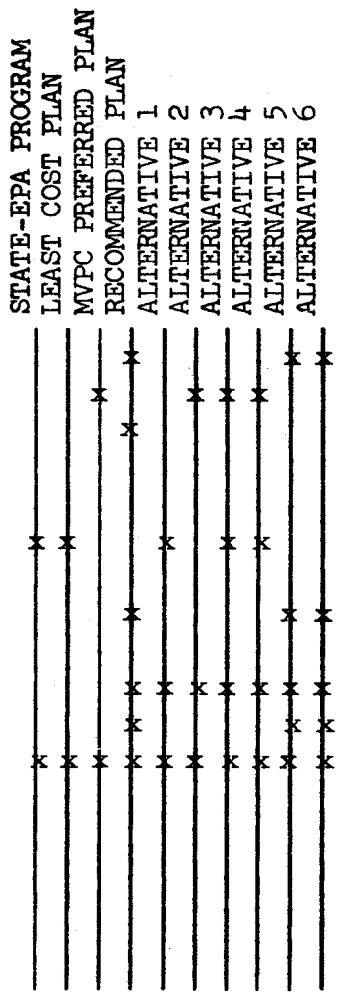
Hygienic

(-L) Transmission lines subject to leakage and pump failures.
(-L) Trace metals in fish flesh, which presently exceed safe standards for human consumption, will continue to biomagnify through the food chain.
(-L) Ineffective virus removal with chlorination.
(+L) Advanced treatment will remove substances that can interfere with disinfection.

SUMMARY OF IMPACTS

Geographical Area Salisbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Aesthetic

(-L) Rapid infiltration system effect on landscape quality.
(-L) Treatment plant and transmission systems' impact on wetlands.
(+L) Spray irrigation of Amesbury flows in Salisbury maintains open space.

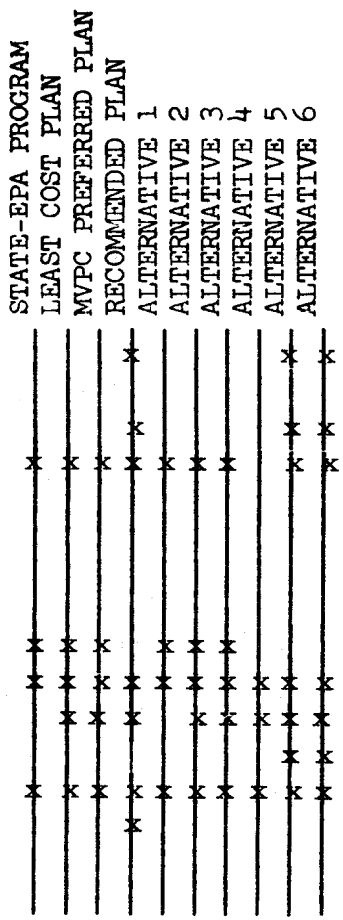
Biological

(-L) Ammonia, residual chlorine or chloramines may exceed acceptable limits in Merrimack estuary.
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.
(+L) Levels of toxic materials reduced.
(-L) Soils marginally suitable for rapid infiltration.
(-L) Accumulation of toxic materials in shellfish would still be possible due to upstream discharges.

SUMMARY OF IMPACTS

Geographical Area Salisbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Engineering

(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.
(+L) Land systems more likely to consistently achieve design capability.
(-L) Operation and maintenance economies.

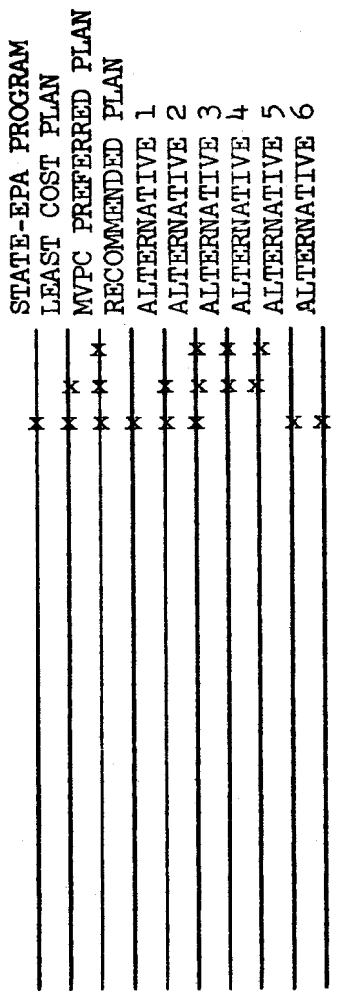
Socio-Economic

(-L) Treatment site compatibility with open space plans.
(+L) Sewer service area supports plans for medium and industrial development.
(+L) Clam flats may be able to open.
(-L) 110 acres removed from roles of taxable land.
(-S) Local traffic patterns affected during construction of collection systems.
(-L) 360 acres removed from roles of taxable land.

SUMMARY OF IMPACTS

Geographical Area Salisbury

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



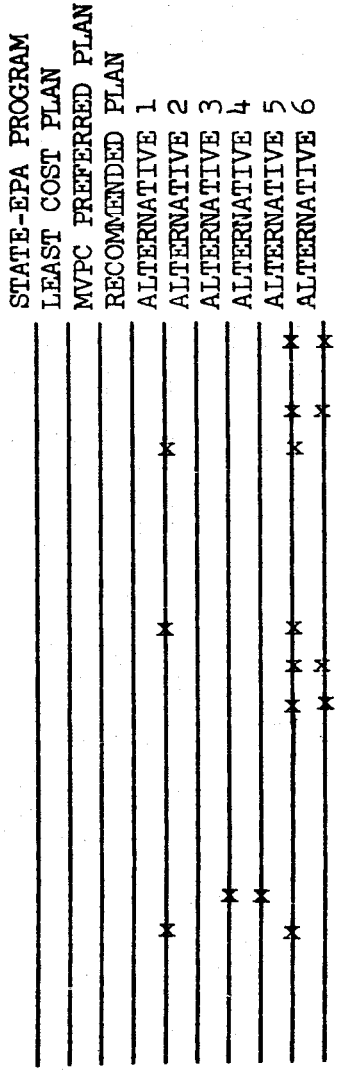
Hygienic

(-L) Transmission lines subject to leakage and pump failures.
(-L) Treatment plant failure will cause health hazard in harvesting clams.
(-L) Ineffective virus removal with chlorination.

SUMMARY OF IMPACTS

Geographical Area Boxford

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Engineering

(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.
(+L) Land systems more likely to consistently achieve design capability.
(-L) Operation and maintenance economies.

Socio-Economic

(-L) Treatment site compatibility with open space plans.
(+L) Economic return on crops harvested.
(-L) 580 acres removed from roles of taxable land.

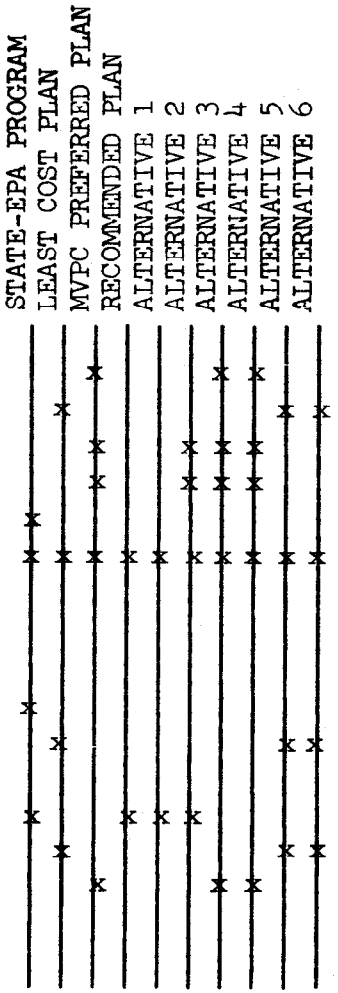
Hygienic

(-L) Transmission lines subject to leakage and pump failures.
(-L) Ineffective virus removal with chlorination.

SUMMARY OF IMPACTS

Geographical Area Haverhill-Groveland

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Aesthetic

(+L) Flow augmentation of Merrimack River during low flow periods.
(-L) 530-acre rapid infiltration system effect on landscape quality.
(-S) Transmission systems impact on natural environment.
(+L) Potential recreational corridors along transmission lines.
(+L) Improved visual quality of Merrimack River.
(+L) Treatment plant design could accommodate need for river access point.

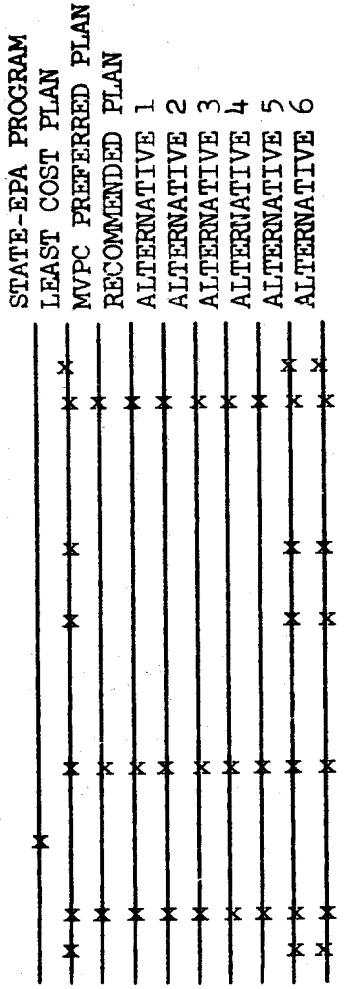
Biological

(-L) Nutrients in Merrimack River may exceed acceptable limits.
(+L) Due to buffering capabilities of land, discharge to land preferred over direct discharge to receiving stream.
(-L) Potential residual chlorine toxicities to aquatic organisms.
(+L) Recharge of groundwater aquifers.
(+L) Flow augmentation will enhance aquatic life during low flow periods especially in river reaches between Lawrence and Haverhill.

SUMMARY OF IMPACTS

Geographical Area Haverhill-Groveland

-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Biological (Cont'd)

(-L) Soils marginally suitable for rapid infiltration in Groveland area.
(+L) Water quality improved to acceptable limits.

Engineering

(+L) Operation would require one-half the manpower, two-thirds the energy needs and one-eighth the chemicals of other alternatives.
(+L) Land systems more likely to consistently achieve design capability.

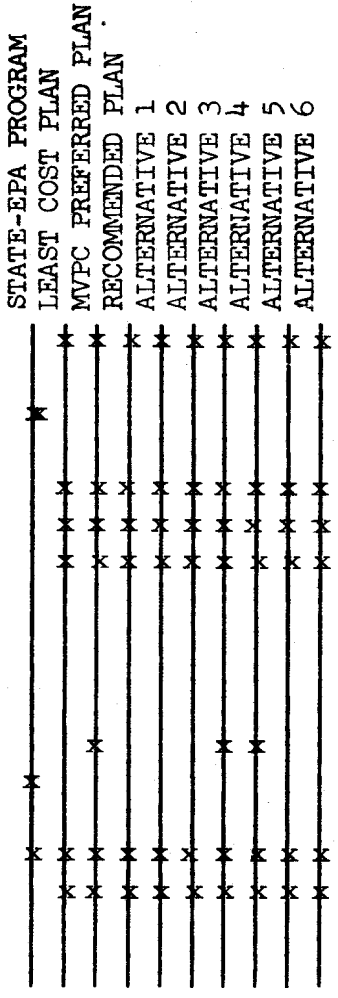
Socio-Economic

(-L) Sewer service in low density area might create pressure for development contrary to open space goals.
(-L) Excessive concentrations of nutrients in Merrimack River will limit recreational benefits.
(+L) Advanced treatment may permit increased recreational pursuits.
(-L) 530 acres removed from roles of taxable land.

SUMMARY OF IMPACTS

Geographical Area Greater Lawrence Sanitary District
(Andover, North Andover, Methuen, Lawrence)

*-L - Adverse impact - long term
-S - Adverse impact - short term
+L - Beneficial impact - long term
+S - Beneficial impact - short term
Blank spaces imply no discernable impact



Socio-Economic

(-L) Sewer service in low density area might create development pressure in Andover, North Andover and Methuen.

(-L) Excessive concentrations of nutrients in Merrimack River will limit recreational benefits.

(+L) Advanced treatment may permit increased recreational pursuits.

(-S) Local traffic patterns affected during construction of collection systems.

(+L) Service sector associated with recreational pursuits will increase with improved water quality.

Hygienic

(-L) Transmission lines subject to leakage and pump failures.

(-L) Trace metals in fish flesh, which presently exceed safe standards for human consumption, will continue to biomagnify through the food chain.

(-L) Ineffective virus removal with chlorination.

(+L) Advanced waste treatment will remove substances that can interfere with disinfection.

G. PUBLIC PARTICIPATION IN IMPACT ASSESSMENT

Impact analysis and evaluation is public participation. The Federal Water Pollution Control Act Amendments of 1972 and the National Environmental Policy Act of 1969 are quite explicit in stating that the public's role in the development of water resources projects and the evaluation of those projects will be substantial. Historically, it was not uncommon for the agency undertaking the study to assimilate the basic data needed for plan formulation, develop the alternatives, select the "best" plan and then present the study's findings to the public. The lack of opportunity for the public to interact with the planning agencies as the plans were being formulated and recommended often resulted in adversary positions leading to extensive court action or costly delays. Many governmental agencies have begun to take the steps and make the necessary changes to elicit public response and promote meaningful public involvement in their planning studies. The Merrimack Wastewater Management Study is an expression of those changes.

What constitutes effective and meaningful public participation and open planning? Opinions concerning the effectiveness of public participation in the Merrimack Study would vary depending on whom was asked the question. "What is the Merrimack Wastewater Management Study?"; "Significant accomplishments were made."; and "Entirely inadequate!" would probably cover the range of responses. Most would recognize the need to develop more effective mechanisms to facilitate the planner-public interface, especially in regard to evaluating the alternatives. By and large efforts to actively involve large numbers of basin residents were less than successful. As experienced in this study, if a small number of actively participating citizens investing many hours of time trying to digest and understand the study had difficulty in grasping the concepts and the technology associated with the various alternatives, new methods have to be explored before a large number of less involved citizens can successfully participate.

The public participation program for the Merrimack Wastewater Management Study drew upon past experiences of the Regional Planning Agencies supplemented by Corps and State agency staffs. A detailed discussion of the process of public participation can be found in the Public Participation Appendix (VI). The purpose of this section will be to focus on the public's role in the evaluation of the impacts and the development of the recommended plan.

The Regional Planning Agencies within the study area were brought under contract with the Corps of Engineers for purposes of technical planning and to assist in carrying out a public participation program in

Question: Rather than investing the dollars for advanced waste treatment of municipal wastes, should we not in fact address ourselves to solving the problems of combined sewers, stormwater overflows, and non-point sources first?

This question is difficult to answer and revolves around the issue of how to invest the available dollars to get the maximum return in water quality improvement. If we knew the quality and quantity of in stream pollutants due to each source of pollution: municipal wastes, industrial wastes, combined sewer overflows, separate storm sewers and non-point sources, the proper course of action would be more lucid. Questions concerning how much of each pollutant is coming from each source of pollution and what impact that incremental loading has on the overall water quality of the Merrimack River are next to impossible to effectively answer at this time. Secondly, the dollar cost of such determinations would be prohibitive. This study has found, however, that non-point sources, principally along feeder streams in areas where homes are on private septic systems, pose major problems in structuring a sound plan for basin-wide management of wastewaters. Feeder streams sampled were particularly high in coliform bacteria and nitrates. What increased water quality related recreational benefits could be achieved on the Merrimack mainstem by solving the non-point source problem is open to extreme speculation and beyond the resources of this study. Until people are willing to talk seriously about hard land use decisions and sound land management practices on a regional basis, the discussion of water quality due to non-point sources will be an academic exercise.

A significant yet crucial finding of this study is that separate stormwater runoff does not pose a serious water quality problem. This finding contradicts information generated in other portions of the country and should be seriously questioned and investigated further. The hypothesis put forth is that New England rainfall patterns do not permit the build up of pollutants to concentrations requiring treatment. Treating stormwater runoff and in turn predicting pollutant reductions in the Merrimack River would require an extensive monitoring and sampling program. The type and intensity of land use, methods and conditions of collection systems, occurrence and intensity of load distributions, all of which vary from region to region and town to town are only a few factors that must be taken into consideration.

Combined sewer overflows in the cities of Lowell, Lawrence and Haverhill do present a cause for concern. Here raw municipal sewage, somewhat diluted with stormwater runoff, bypasses sewage treatment plants and is discharged directly to the river. As is the case with non-point sources, however, the incremental improvements in water quality

as a result of treating combined sewers specifically is not known. It's fair to assume any discharge of raw wastewater would effectively inhibit the recreational potential of the Merrimack River. Although the actual quality of combined sewer overflows is of question, the quantities of flow were determined for the Lowell, Lawrence, and Haverhill areas. The costs for treating these flows as well as a full discussion of the treatment alternatives can be found in Appendices II and III.

The major water quality analysis effort of this study was directed towards assessing the incremental benefits in water quality given advanced waste treatment of municipal wastes and combined sewer flows jointly. Study findings indicate concentrations of nitrogen and phosphorus for the Merrimack mainstem would be reduced to acceptable EPA standards for aquatic life with advanced waste treatment of municipal wastes and combined sewer flows. As is true for the State-EPA implementation schedule, some points of clarification are needed.

1) It is assumed the advanced waste treatment plants will be able to achieve the designated effluent quality. This can be seriously questioned since the track record of advanced waste treatment plants is virtually nonexistent. In essence, the reliability and effectiveness of advanced waste treatment processes cannot be assured.

2) It is assumed the National Pollutant Discharge Elimination System (Permits Program) for discharges of point sources other than municipal outfalls will be strictly enforced.

3) The model and calculations used in the analysis make argumentative assumptions.

The statements above point out there are factors such as the operation and maintenance of advanced systems which may periodically lower water quality levels below acceptable standards. Therefore, the recreational benefits designated in the socio-economic report such as swimming, boating and fishing can be questioned even with the implementation of advanced waste treatment.

Based on the number of unknown factors and questionable findings, firm conclusions on water quality benefits and levels of water quality improvement can only be described as speculative at best. The monetary investment required to achieve speculative benefits is difficult to justify at this time. The logical approach is to continue with the State-EPA program for secondary treatment and monitor the improvement of the river's water quality. Only then can a sound decision be made to proceed or not to proceed with advanced waste treatment.

Question: Can we afford the price tag of advanced waste treatment systems?

The answer to this question is dependent upon a number of variables peculiar to each community in the study area. If a given town has a substantial industrial base contributing to the total municipal flow, user charge allocations could significantly reduce the town's expenditure on both construction and operation and maintenance costs. Another important factor is to consider whether or not a given town has an existing sewer collection system and treatment facility. Also many communities have already obligated substantial sums of money under the ongoing State-EPA implementation program which should be credited towards the total cost of advanced waste treatment. As can be seen from Tables 1 and 2, incremental tax increases for each community under the recommended plan are quite variable. Since in most cases the recommended plan involves an expansion or an "add on" to treatment plants proposed under the implementation program, the incremental tax increase to achieve advanced waste treatment does not appear to be an insurmountable burden. The final step is not the cause for concern, however. With a current unemployment rate of some 10-12 percent throughout the study area, the anticipated fiscal impacts of achieving the 1977 requirements of PL 92-500 pose the greatest threat to the financial security of the towns of the Merrimack River Basin. One of the key factors in such a determination is the cost of local collection systems. Municipal sewer systems are not presently eligible for State-Federal cost sharing and construction costs must be borne by the city or town. In most communities, particularly those that are rural in character or have limited sewer service areas in need of expansion, the cost for collection systems exceed treatment plant costs by two or three times. The communities of the Merrimack Basin are hard pressed to make ends meet now; unless substantial sums of money are made available to aid the towns in construction of sewer collection systems, the 1977 requirements will probably not be met let alone the long range goal of "zero discharge of pollutants."

The previous discussion had admittedly been cursory in nature, for a full understanding of municipal finance impacts, factors to be considered and anticipated costs for the years 1977, 1983 and 1985, refer to Appendix IV-A, Socio-Economic Impacts and Appendix III, Design and Costs.

TABLE 1

Northern Middlesex Area Commission
Tax Rate Increases Due to the Non-Industrial
Portion of Local Share of Construction Costs
Preferred Alternative: 1977, 1983, 1985

City or Town	FY 1973 Tax Rate	FY 1977 Increase	FY 1977 New Tax Rate	FY 1983 Increase	FY 1983 New Tax Rate	FY 1985 Increase	FY 1985 New Tax Rate
Billerica	$205.50	$28.08	$233.58	$0.11	$233.69	$0.94	$234.63
Chelmsford	44.00	2.08	46.08	0.03	46.11	0.25	46.36
Dracut	162.00	29.55	191.55	0.07	191.62	0.60	192.22
Dunstable*	180.00	3.22	183.22	-0-	183.22	0.82	184.04
Lowell	147.40	4.89	152.29	0.15	152.44	1.17	153.61
Pepperell	64.00	2.36	66.36	0.06	66.42	0.63	67.05
Tewksbury	32.00	0.57	32.57	0.01	32.58	0.09	32.67
Tyngsborough*	44.00	8.76	48.76	0.27	49.03	0.21	49.24
Westford	53.50	4.19	57.69	0.02	57.71	0.23	57.93

*Communities with future sewerage systems. Costs include all collection, treatment, interception, discharge and storage systems for sanitary wastewater and combined flows.

TABLE 2

Merrimack Valley Planning Commission
Tax Rate Increases Due to the Non-Industrial
Portion of Local Share of Construction Costs
Preferred Alternative: 1977, 1983, 1985

City or Town	FY 1973 Tax Rate	FY 1977 Increase	FY 1977 New Tax Rate	FY 1983 Increase	FY 1983 New Tax Rate	FY 1985 Increase	FY 1985 New Tax Rate
Amesbury	$52.00	$0.67	$52.67	$0.05	$52.72	$1.25	$53.97
Andover	54.00	0.25	54.25	0.01	54.26	0.08	54.34
Boxford*	110.00	0.15	110.15	-0-	110.15	-0-	110.15
Georgetown*	60.00	0.26	60.26	-0-	60.26	-0-	60.26
Groveland	64.00	14.35	78.35	0.03	78.38	0.34	78.72
Haverill*	150.00	7.49	157.49	0.13	157.62	1.19	158.81
Lawrence	153.90	0.86	154.76	0.06	154.82	0.59	155.41
Merrimac	84.20	11.94	96.14	0.05	96.19	1.41	97.60
Methuen	166.00	4.93	170.93	0.07	171.00	0.63	171.63
Newbury	96.00	67.81	163.87	0.24	164.11	1.91	166.02
Newburyport	31.00	4.70	35.70	0.05	35.75	0.42	36.17
North Andover	64.00	5.86	69.86	0.04	69.90	0.37	70.27
Rowley*	58.00	-0-	58.00	-0-	58.00	-0-	58.00
Salisbury	40.00	3.37	43.37	0.09	43.46	4.62	48.08
West Newbury*	67.00	0.76	67.76	-0-	67.76	0.69	68.45

*Communities with future sewerage systems. Costs include all collection, treatment, interception, discharge and storage systems for sanitary wastewater and combined flows.

I. WATER RESOURCES COUNCIL'S PRINCIPLES AND STANDARDS

1. Preface

The United States Water Resources Council's Principles and Standards for Planning Water and Related Land Resources" were published in an effort to improve upon existing planning criteria or to develop new criteria for Federally funded projects involving water and related land resources.

The major significance of the Principles and Standards is that they establish Federal planning policy stating environmental benefits and costs are to be evaluated on an equal basis with economic benefits and costs. In fact, a plan with no significant economic benefit could be recommended if it proposed opportunities for long-term environmental benefits. Recognizing that resolving the issue of economic vs. environmental tradeoffs can be a difficult undertaking, the intent of the Principles and Standards is to provide a planning methodology to facilitate the documentation of study findings and to assist the decision making process.

Although the Principles and Standards express a sincere desire on the part of the Federal government to adjust to a somewhat changing American value system, the attempts to understand and comply with the new standards have been frustrating. The issue is quite specific! Do increased shortrun economic costs offset somewhat speculative and long term environmental benefits? As experienced in the Merrimack Wastewater Management Study, the philosophy and policy that environmental concerns are on an equal basis with dollar signs has yet to be accepted by many personnel within the implementing agencies. The Technical Subcommittee deliberated extensively on matters concerning "economic quantifiables" vs. "environmental unquantifiables" oftentimes with no clear resolution of the issue. In a state burdened with high unemployment, hard pressed to finance proposed treatment plants under the ongoing implementation program, the investment of additional money to accommodate speculative environmental benefits is difficult to accept.

2. Overview

The Water Resources Council established the "Principles and Standards for Planning Water and Related Land Resources" effective October 25, 1973, pursuant to section 103 of the Water Resources Planning Act (PL 89-80). Published in the September 10, 1973 Federal Register, the Principles and Standards specify that the two major

"objectives" to be considered in Federal planning projects are national economic development (NED) and environmental quality (EQ). The Standards also specify that beneficial and adverse effects shall be measured on regional development (RD) and social well-being (SW), although these latter two concerns are not labeled "objectives." The Principles and Standards also lay out the desired plan formulation process, in terms of the steps which must be undertaken and their specific content.

The key elements in this planning process are (1) that a number of objectives must be considered and the tradeoffs between them be explicitly examined, and (2) that plans be drawn up and analyzed in such a way that all the feasible alternatives are considered and their effects on the objectives measured.

The objectives of NED and EQ are to serve as the goals toward which the planning process is directed. These objectives in turn form the basis of the analysis of the tradeoffs between alternative plans. The objectives and their components are explained as follows in the Principles and Standards:

1. National Economic Development. The national economic development objective is enhanced by increasing the value of the nation's output of goods and services and improving national economic efficiency.

   National economic development reflects increases in the Nation's productive output, an output which is partly reflected in a national product and income and accounting framework designed to measure the continuing flows of goods and services into direct consumption on investment.

   In addition, national economic development is affected by beneficial and adverse externalities stemming from normal economic production and consumption, imperfect market conditions, and changes in productivity of resource inputs due to investment. National economic development is also affected by the availability of public goods which are not accounted for in the national product and income accounting framework. Thus, the concept of national economic development is broader than that of national income and

is used to measure the impact of governmental investment on the total national output. The gross national product and national income accounts do not give a complete accounting of the value of the output of final goods and services resulting from governmental investments because only government expenditures are included. This is especially true in those situations where governmental investment is required to overcome imperfections in the private market. Therefore, national economic development as defined in these standards is only partially reflected in the gross national product and national income accounting framework. A similar situation prevails where a private investment results in the production of final public goods or externalities that are not exchanged in the market.

Components of the national economic development objective include:

(a) The value of increased outputs of goods and services resulting from a plan. Developments of water and land resources result in increased production of goods and services which can be measured in terms of their value to the user. Increases in crop yields, expanding recreational use, and peaking capacity for power systems are examples of direct increases in the Nation's output which result from water and related land resources developments. Moreover, such developments often result in a change in the productivity of natural resources and the productivity of labor and capital used with these resources. Increased earnings from changes in land use, reduced disruption of economic activity due to droughts, floods and fluctuating water supplies, and removal of constraints on production through increased water supplies are examples of direct increases in productivity from water and land development that contribute to national output. Development of water and land resources may result in increased production from the employment of otherwise unemployed or underemployed resources, as well as contributions to increased output due to cost savings resulting in the release of resources for employment elsewhere.

(b) The value of output resulting from external economies. In addition to the value of goods and services derived by users of outputs of a plan, there may be external gains to other individuals or groups.

2. Environmental quality. The environmental objective is enhanced by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems in the area under study and elsewhere in the Nation. This objective reflects society's concern and emphasis for the natural environment and its maintenance and enhancement as a source of present enjoyment and a heritage for future generations.

Explicit recognition should be given to the desirability of diverting a portion of the Nation's resources from production of more conventional market-oriented goods and services in order to accomplish environmental objectives. As incomes and living levels increase, society appears less willing to accept environmental deterioration in the market place.

Responsive to the varied spiritual, psychological, recreational, and material needs, the environmental objective reflects man's abiding concern with the quality of the natural physical-biological system in which all life is sustained.

Components of the environmental objective include the following:

(a) Management, protection, enhancement, or creation of areas of natural beauty and human enjoyment such as open and green space, wild and scenic rivers, lakes, beaches, shores, mountain and wilderness areas, and estuaries;

(b) Management, preservation, or enhancement of especially valuable or outstanding archeological, historical, biological (including fish and wildlife habitat), and geological resources and ecological systems;

(c) Enhancement of quality aspects of water, land, and air by control of pollution or prevention of erosion and restoration of eroded areas embracing the need to harmonize land use objectives in terms of productivity for economic use and development with conservation of the resource;

(d) Avoiding irreversible commitments of resources to future uses: While all forms of development and use affect and sometimes change the tenuous balance of fragile aquatic and terrestial ecosystems, the implication of all possible effects and changes on such systems is imperfectly understood at the present time. In the absence of absolute measures or standards for reliably predicting ecological change, these planning standards emphasize the need for a cautionary approach in meeting development and use objectives in order to minimize or preclude the possibility of undesirable and possible irreversible changes in the natural environment;

(e) Others. Given its broad and pervasive nature, it is not practical to specifically identify in these standards all possible components of the environmental quality objectives. If other components are recognized, they should be explicitly identified and accommodated in the planning process.

In addition to these two objectives, there are two other overall goals which should be considered: regional development and social well-being. These goals are of a distinctly different character in the context of the WRC planning process. While the two "objectives" must always be considered, the effects on regional development and social well-being must only be considered "where appropriate". Furthermore, plan formulation and selection must be based upon the effects of alternative plans only upon the two major objectives, while the effects on regional development and social well-being must only be "displayed". These goals of regional development and social well-being are explained in the following sections from the Principles and Standards: (8)

A. Beneficial and Adverse Effects on Regional Development

Through its effects--both beneficial and adverse--on a region's income, employment, population, economic base, environment, social development, and other factors, a plan may exert a significant influence on the course and direction of regional development.

The regional development account embraces several types of beneficial effects, such as (a) increased regional income; (b) increased regional employment; (c) population distribution; (d) diversification of the regional economic base; and (e) enhancement of environmental conditions of special regional concern. There are major difficulties in estimating some components of the regional development account, such as the location effects as well as estimating the effects of a plan on regional employment, population distribution, and economic base and stability. For this reason a complete display of beneficial and adverse effects for all components in the regional development account will not be made for a plan unless directed by a Department Secretary or head of an independent agency.

The evaluation of various classes of beneficial and adverse effects on the regional development account is discussed below.

B. Beneficial and Adverse Effects on Social Well-Being

In addition to the effects described above, most water and land resource plans have beneficial and adverse effects on social well-being. These effects reflect a highly complex set of relationships and interactions between inputs and outputs of a plan and the social and cultural setting in which these are received and acted upon. These effects will be reported as appropriate in the system of accounts for each alternative plan.

3. Findings

In accordaince with the Water Resources Council's Principles and Standards, the following is a summarization of benefits and costs for each alternative examined during the Merrimack Wastewater Management Study.

Objectives		Benefits and Costs of Alternatives
		State-EPA Implementation Program
Environmental Quality	Benefits:	Water Quality: Improved visual quality of Merrimack River. Aesthetic Values: Proper treatment plant design and landscaping could accommodate need for river access points.
	Costs:	Water Quality: Non-point sources, combined sewer overflows and efficiency of secondary treatment plants may prohibit achievement of designated water quality standards. Chlorination may cause adverse impact on aquatic organisms.
Social Well Being	Benefits:	Municipal Services: Sewer service areas support most community growth and development goals. Recreation: Recreational activities associated with visual improvement in water quality will increase.
	Costs:	Public Health: Failing on-lot septic systems will continue to degrade water quality of smaller tributaries. Finfish may continue to accumulate toxic substances beyond safe levels for human consumption.
National Economic Development	Benefits:	Manufacturing: Minimal impact on local industry.
	Costs	Monetary Cost: Estimated total project cost of State-EPA plan is $330 million.
Regional Development	Benefits:	Employment: Construction of facilities and operation & maintenance requirements will create job opportunities.
	Costs:	Municipal Finance: Local taxes will increase.

Objectives		Impacts Common to Water-Oriented Alternatives
Environmental Quality	Benefits:	Water Quality: Nutrient concentrations will be reduced to acceptable limits. Gamefish populations will increase. Aesthetic Values: Transmission systems provide opportunities for recreational pursuits.
	Costs:	Water Quality: The effectiveness and reliability of advanced waste treatment systems is questionable. Considering possibilities of treatment plant failure, direct discharges to receiving streams would have an adverse impact on aquatic organisms. Chlorination may cause adverse impact on aquatic life.
Social Well Being	Benefits:	Recreation: Water contact recreational activities: swimming, boating, fishing, etc., will increase in freshwater segments of the basin. Municipal Services: Sewer service areas generally compatible with regional land use plans. Public Health: Elimination of residual toxics will prevent their accumulation in finfish.
	Costs:	Transportation: Local traffic patterns will experience short-term disruptions during construction.
National Economic Development	Costs:	Manufacturing: Stringent abatement actions necessary to comply with effluent standards will have an adverse impact on local industry & increase unemployment. Treatment plant operation will increase energy demands.
Regional Development	Benefits:	Municipal Services: Service sector associated with increased recreational activities will markedly improve. Employment: Construction and operation & maintenance of treatment facilities will create increased labor opportunities.
	Costs:	Municipal Taxes: Local taxes will increase significantly for some communities.

Objectives		Alternative #1 (Water Decentralized)
Environmental Quality	Benefits:	Water Quality: A number of small treatment plants effectively operated could best insure maximum water quality improvement.
	Costs:	Water Quality: Reduced operational efficiency probable with a number of small treatment plants will not produce maximum water quality improvement.
Social Well Being	Benefits:	Land Use: Sewer service areas generally support regional land use plans. Waterfront property will increase in value. Municipal Services: Improved water quality of Merrimack River will increase its utility as a water supply source.
	Costs:	Municipal Services: Sewer service systems would be constructed in rural towns that may not need them to solve potential future problems. Municipal Services related to increased growth and development - water supply, schools, etc., will have to expand.
National Economic Development	Costs:	Monetary Costs: Estimated total project cost is $714 million. Commercial Fisheries: Discharge of secondary effluent to the estuary may prohibit shellfish harvesting.
Regional Development	Costs:	Housing: local development pressures may arise with expansion of sewer services.

Objectives		Alternative #2 (Water Partially Decentralized)
Environmental Quality	Benefits:	Water Quality: Same as Alternative #1
	Costs:	Water Quality: Regional Treatment systems will reduce flow in small feeder streams. See Alternative #1.
Social Well Being	Benefits:	Same as Alternative #1.
	Costs:	Public Health: Transmission systems are subject to leakage and pump failure creating potential health hazard. See Alternative #1.
National Economic Development	Costs:	Monetary Costs: Estimated total project cost is $726 million. Commercial Fisheries: Discharge of secondary effluent to the estuary may prohibit shellfish harvesting.
Regional Development	Costs:	Same as Alternative #1.

Objectives		Alternative #3 (Water Centralized)
Environmental Quality	Benefits:	Aesthetic Value: Extensive transmission systems provide multiple use opportunities consistent with regional land use and recreation plans.
	Costs:	Water Quality: Regional configuration reduce flow of smaller feeder streams. The malfunction of large treatment plants would have a major adverse impact on aquatic organisms. Aesthetic: Large treatment plants will disrupt natural riverscape views.
Social Well Being	Benefits:	Same as Alternative #1.
	Costs:	Public Health: Transmission systems are subject to leakage and pump failures creating potential health hazards. Transportation: Extensive transmission systems will temporarily disrupt local traffic patterns.
National Economic Development	Benefits:	Commercial Fisheries: Discharge of advanced effluent to the estuary will increase possibilities of shellfish harvesting.
	Costs:	Monetary Costs: Estimated total project cost is $778 million.
Regional Development	Costs:	Same as Alternative #1.

Objectives		Alternative #4 (Water Regional)
Environmental Quality	Benefits:	Water Quality: Large volumes of water centrally located could take maximum advantage of potential reuse opportunities, i.e. water supply.
	Costs:	Water Quality: Reduction of river flow would have adverse impact on aquatic organisms. The malfunction of large treatment plants would have a major adverse impact on aquatic organisms.
Social Well Being	Benefits:	Same as Alternative #1.
	Costs:	Recreation: Reduced flows in certain river segments would effectively limit recreational opportunities during low flow periods. See Alternative #1.
National Economic Development	Benefits:	Same as Alternative #3.
	Costs:	Monetary Costs: Estimated total project cost is $766 million.
Regional Development	Costs:	Same as Alternative #1.

Objectives		Impacts Common to Land-Oriented Alternatives
Environmental Quality	Benefits:	Water Quality: Nutrients currently being discharged to local streams would be utilized by agricultural crops. Groundwater recharge stabilizes local aquifers. Due to buffering capabilities of land discharge to land preferred over direct discharge to receiving stream.
	Costs:	Aesthetic Values: Rapid infiltration systems degrade natural landscape. Terrestrial Environment: Construction of rapid infiltration systems will reduce wildlife habitat.
Social Well Being	Benefits:	Municipal Services: Land treatment systems generally less costly to operate and maintain. Land Use: Land treatment may be a tool for influencing growth and development patterns.
	Costs:	Public Health: Detailed investigations are required before land treatment systems can be fully endorsed. Possible risk of groundwater contamination. Transportation: Local traffic patterns will experience short-term disruptions during construction.
National Economic Development	Benefits:	Agriculture: Economic return on crops harvested from spray irrigation sites. Nutrient content of wastewater used as fertilizer.
	Costs:	Manufacturing: Stringent abatement actions necessary to comply with effluent standards will have an adverse impact on local industry and increase unemployment.
Regional Development	Benefits:	Municipal Service: Service sector associated with increased recreational activities will markedly improve.
	Costs:	Municipal Taxes: Local taxes will increase significantly for some communities.

Objectives		Alternative #5 (Land Decentralized)
Environmental Quality	Benefits:	Terrestrial Environment: 1895 acres of spray irrigation sites could enhance wildlife productivity. Effluent nutrients would be available for crop uptake.
	Costs:	Terrestrial Environment: 995 acres of rapid infiltration systems degrade natural landscape. Spray irrigation systems can only be effectively utilized during an approximate 26-week period.
Social Well Being	Benefits:	Public Health: Small land application systems properly managed and monitored could be more reliable than advanced waste treatment plants. Recreation: Potential multiple use at spray irrigation sites.
	Costs:	Land Use: 2890 acres of land would be removed from tax roles. Potential sites for land treatment may conflict with local development plans. Land acquisition costs may be expensive.
National Economic Development	Benefits:	Agriculture: Productivity of agricultural crops enhanced.
	Costs:	Monetary Costs: Estimated total project cost is $803 million.
Regional Development	Benefits:	Employment: Construction and operation and maintenance of treatment systems will create increased labor opportunities.
	Costs:	Housing: Homes within potential land application sites would have to be relocated.

Objectives		Alternative #6 (MVPC only) (Land Central)
Environmental Quality	Benefits:	Terrestrial Environment: 1480 acres of spray irrigation sites could enhance wildlife productivity. Water Quality: Flow augmentation during summer months would enhance aquatic life.
	Costs:	Terrestrial Environment: 1315 acres of rapid infiltration systems will degrade natural landscape. See Alternative #5.
Social Well Being	Benefits:	Recreation: Potential multiple use of spray irrigation sites.
	Costs:	Land Use: 2795 acres of land would be removed for tax roles. Potential sites for land treatment may conflict with local development plans.
National Economic Development	Benefits:	Agriculture: Same as Alternative #5
	Costs:	Monetary Costs: Estimated total project cost is $806 million.
Regional Development	Benefits:	Same as Alternative #5.
	Costs:	Housing: Homes within potential land application sites would have to be relocated.

Objectives		Recommended Plan
Environmental Quality	Benefits:	Water Quality: Nutrient concentrations in Merrimack River will be reduced to acceptable levels. Gamefish populations will increase. A number of small treatment plants effectively operated could best insure maximum water quality improvement. Where land treatment systems are proposed, nutrients currently being discharged to local streams would be utilized for agricultural production and groundwater recharge would assist the stabilization of local aquifers. Aesthetic Values: Transmission systems provide opportunities for recreational pursuits if proper consideration is given to design and planning.
	Costs:	Water Quality: Potential chlorine residual toxicities to aquatic organisms. Reduced operational efficiency probable with a number of small treatment plants would not maximize water quality improvements. Treatment plant failure would have an adverse impact on aquatic life. Aesthetic Values: 650 acres of rapid infiltration sites will degrade natural landscapes.
Social Well Being	Benefits:	Recreation: Water contact recreational activities will increase. Potential multiple use of treatment facilities. Municipal Services: Sewer service areas generally compatible with regional land use plans. Improved water quality of Merrimack River will increase its utility as a water supply source. Where appropriate, land treatment systems are generally less costly to operate and maintain. Land Use: Effective land use management plans for rural communities would reduce non-point sources of pollution.
	Costs:	Municipal Services: Services related to increased growth and development-water supply, schools, etc. will have to expand with expansion of sewer services. Public Health: Possible risk of groundwater contamination at rapid infiltration sites. Transportation: Local traffic patterns will experience short-term disruptions during construction. Land Use: 1400 acres of land would be removed from tax roles. Potential sites for land treatment may conflict with local development plans. Land acquisition costs may be expensive.

National Economic Development	Benefits:	Agriculture: Economic return on crops harvested from spray irrigation site. Nutrient content of wastewater utilized as fertilizer. Productivity of agricultural crops enhanced.
	Costs:	Manufacturing: Stringent abatement actions necessary to comply with effluent standards will have an adverse impact on local industry and increase unemployment. Monetary Costs: Estimated total project cost is $722 million.
Regional Development	Benefits:	Municipal Services: Service Sector associated with increased recreational activities will markedly improve. Employment: Construction and operation and maintenance of treatment facilities will create increased labor opportunities.
	Costs:	Municipal Taxes: Local taxes will increase significantly for some communities.